POWER

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Thanksgiving

TO THIS festival we come in a spirit of contentment and gratitude for the many blessings that we are permitted to enjoy; for health and home and friends and means and opportunities.

Whether in various minds these thanks are rendered to a bewhiskered Deity sitting upon an alabaster throne or to a vague personification of the collective causes which make us what we are, matters little.

We come in a spirit of good will and happiness, of gratification and of gratitude.

This is the day when we look for and especially emphasize the good things of life, when we gather and take account of the harvest, particularly a day of family reunions and the reinforcement of the ties of kinship.

In New England it is preceded in the spring, by another day devoted, nominally at least, in contrast with the hearty good cheer of the later festival, to fasting and prayer for the success of the crops about to be sown.

In this season of thanksgiving may few of us be tortured by remorse at our failure so to sow and cultivate good fellowship and useful endeavor that our harvest is lacking in the beneficences which it is the purpose of the day to signalize.

F. R. Low

World's Largest Boilers at Beacon Street Heating Plant

By J. H. WALKER
Superintendent of Central Heating, The Detroit Edison Company

DISTRICT heating in Detroit, its present extent and anticipated future, is well illustrated by the new Beacon Street plant now ready for service. Eventually, this station will contain twelve great boilers, each having nearly an acre of steam-making surface and exceeding in size any boiler heretofore constructed. Other unusual features include a water-treating system of the zeolite type, special mono-rail coal-handling system and a tandem turbo-generator to maintain the heat balance.

IN DETROIT the central heating system supplies steam to about two thousand customers in the central business and apartment building district, with a total connected load of 4,543,000 sq.ft. of radiation. Steam has been supplied by four boiler plants that have been built and extended at various times as increased capacity was needed. The service is popular, and as the growth of Detroit's business section in the last decade has been tremendous, the ultimate capacity of the present plants had been reached. With the addition of boiler units from time to time the Beacon Street plant will take care of the expansion of the service for several years. As it goes into operation, the Farmer Street plant, the oldest of the group, will be shut down. It is interesting to note that the capacity of one boiler at Beacon Street will exceed considerably the output of the entire Farmer Street plant.

As previously intimated, the new plant is designed to contain, eventually, twelve boilers, each having 41,500 sq.ft. of heating surface. The first section of the plant, now practically ready for service, has two of these boilers, and a third unit is scheduled for 1927.

Fig. 2 shows the situation of the plant with respect to the steam distribution system. The site is away from the district of tall buildings and is not likely to be surrounded by them. Consideration has been given to a location near a railroad track about 3,300 ft. distant from the present site, to avoid the haulage of coal, but although the transmission of steam to the centers of load over that distance would have been feasible, the heavy investment costs in tunnels and feeder pipes would have more than offset the saving in the cost of coal hauling. The present practice at the other plants, of delivering coal by motor trucks, will be followed.

Primarily, the new station will be a heating plant. The generation of electric current on a large scale and the distribution of low - pressure exhaust steam were given up in Detroit several years ago, largely because of the inadequacy of the existing distribution mains and because of the prohibitively large mains that it would have been necessary to install. Some of the steam generated at Beacon Street will be passed through turbines for the extraction of a limited amount of energy, this feature, however, being entirely incidental to the main purpose of the plant.

Because of the poor annual load factor that is characteristic of a heating load in this latitude, the plant is not designed for extremely high efficiency, but such fuel-saving refinements as could be justified have been adopted. The annual load factor of the heating service ranges from 25 to 30 per cent.

With the benefit of operating experience with both methods of firing, stokers were chosen after careful consideration of their advantages as compared with pulverized-coal burning. The choice was based chiefly upon two reasons related to the location and function of the plant.

Operating a pulverized-coal preparation plant in a downtown district was not thought desirable because of the noise, dirt and hazard believed inseparable from it in the present state of the art. There was, of course, the alternative of building a separate preparation plant at the railroad siding, but this arrangement would have been uneconomical, particularly in view of the poor annual load factor. At the time the decision was made, methods of removing the ash dust from the gases had not been perfected sufficiently to insure against the discharge of ash being a source of annoyance to surrounding buildings.

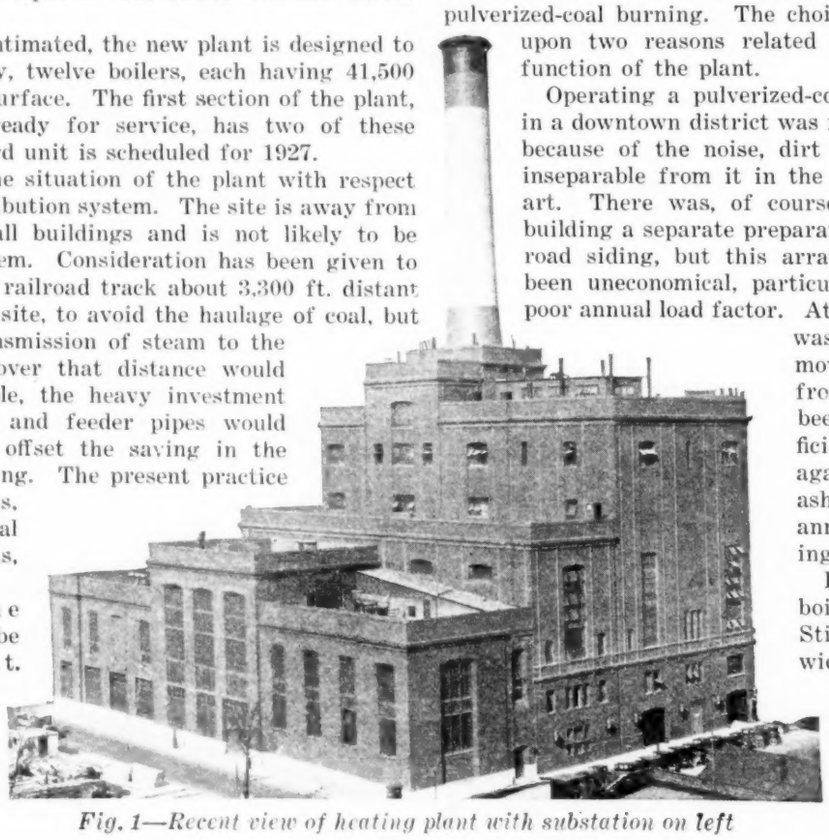


Fig. 1—Recent view of heating plant with substation on left

Each of the two big boilers is of the W Stirling type, 53 tubes wide, designed for an operating pressure of 160 lb. gage. General over - all dimensions are slightly greater than for other boilers of

the same type, but the increased amount of heating surface was made possible principally by utilizing, for additional tubes, the space ordinarily occupied by the superheater and by enlarging the drums to 54 in. diameter, thus permitting the installation of still more rows

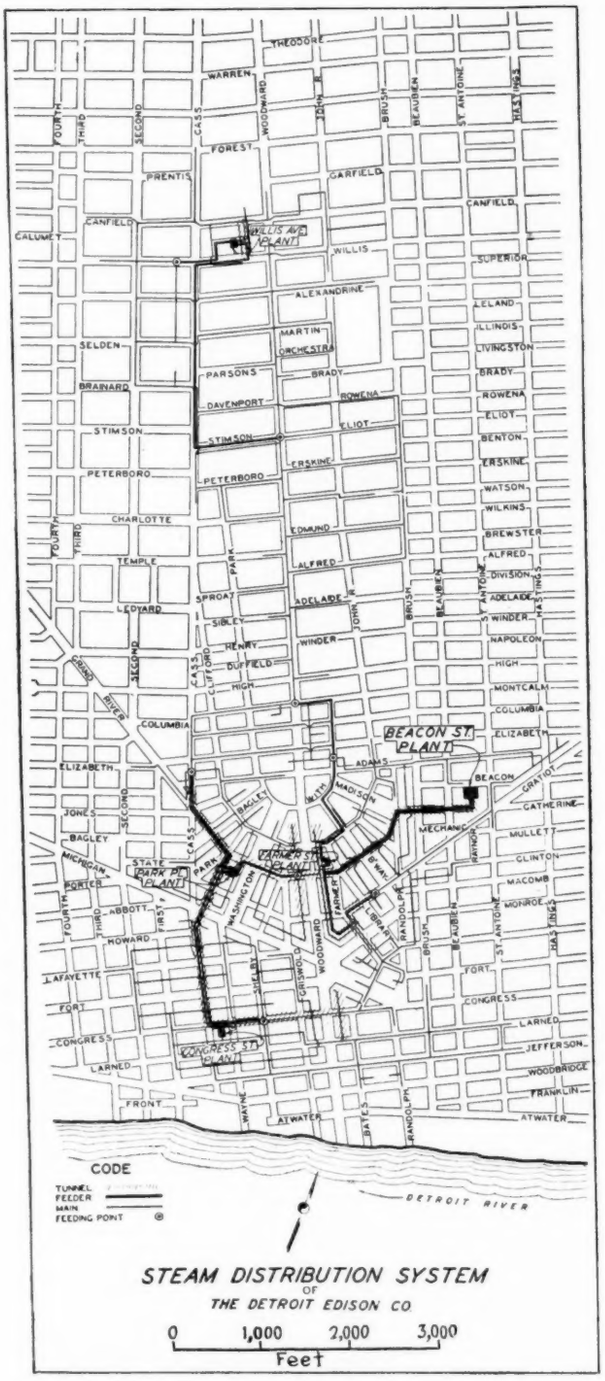


Fig. 2—Detroit's central heating system covers 1¼ square miles and reaches 2,000 customers

of tubes. This added heating surface, obtained at small additional cost, undoubtedly will increase the efficiency and capacity of the unit, and the exit temperatures for a given rate of fuel consumption should be lower than heretofore obtained with Stirling boilers. The spread between mud drums is greater than in any previous design to allow the use of vertical front walls instead of the inward leaning walls of former practice. A cross-section of the entire boiler unit is shown in Fig. 4.

Two inclined 14-retort underfeed stokers, 29 tuyeres long, serve each boiler. A new feature is a belt of air-cooled cast-iron plates extending completely around the furnace at the fuel-bed level to prevent the adhesion of clinker to the furnace walls, which always has been troublesome. Air for cooling these plates will be taken from the plenum chamber under the stoker. After flowing through the passages behind the cooling plates, the air will be passed through the stoker and used for combustion. When the boiler is banked, the cooling air will be discharged into the boiler room.

According to the manufacturer's rating the coal-burning capacity of the double-stoker installation will be sufficient to operate the boiler at 300 per cent of rating, and it is planned to operate down to as low as 50 per cent of rating. It has been found that ability to operate at low ratings, with the consequent elimination of banking losses, is desirable.

Walls of the setting are of solid firebrick with courses

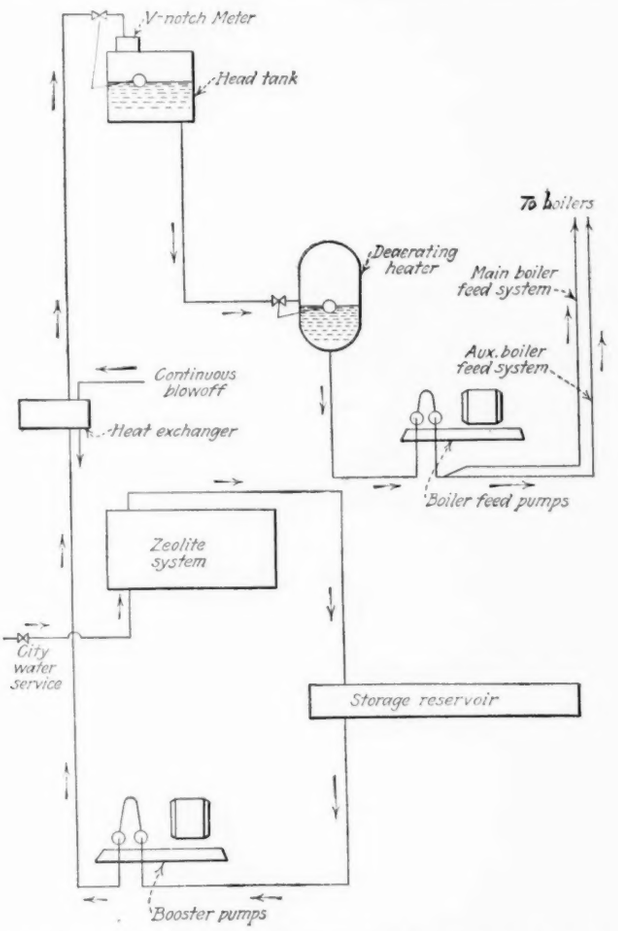


Fig. 3—The simple feed-water system includes zeolite and acid treatment

of special brick, at 2½-ft. intervals, tied back to structural steel framing to hold the wall in the perpendicular. Arches in the end walls relieve the hottest portion of the brickwork from carrying the weight of the upper part of the walls. This construction makes it possible to rebuild the lower walls without disturbing the upper brickwork. The accompanying table gives some of the leading dimensions of the boiler unit.

Air preheaters and economizers have been omitted although sufficient space has been left so that either can be installed later, in the event that the relation between coal cost and investment changes sufficiently to make their use profitable. At present it is impossible

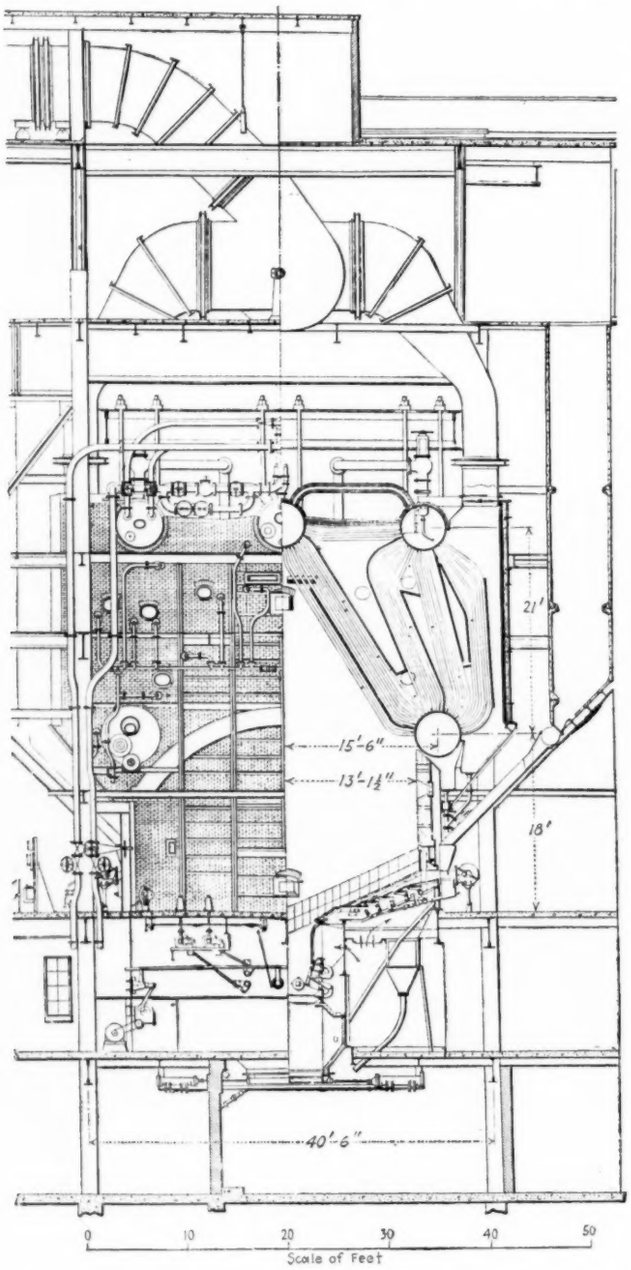


Fig. 4 — The world's largest boiler affords maximum capacity per square foot of ground area. The narrow coal bunker is typical of efforts to economize space

to justify the additional investment. Each boiler unit has individual forced-draft and induced-draft fans. Three boilers are to be served by one stack.

House Turbine for Auxiliaries

Boiler-feed and booster pumps are driven by steam turbines, while the forced- and induced-draft fans, the stokers and the miscellaneous auxiliaries are driven by direct-current motors to which the current is supplied by a house-service turbo-generator. A stand-by source of power is provided from an adjoining electrical substation. The advantages of motor drive in speed regulation and convenience of operation are thus obtained where desirable, while the steam drive for the pumps gives greater reliability for these essential auxiliaries.

Rated at 2,400 kw., the house service unit consists of a turbine of the straight impulse type driving a 275-volt direct-current generator through reduction gears. The special voltage is necessary because of the connection with the stand-by source of power in the substation, the bus here necessarily having a voltage in excess of the 240-volt network.

Exhaust steam from the turbines driving the pumps and from the house-service turbine is used to heat the feed water, which is nearly all makeup taken from the city mains. The deficiency between the available ex-

PRINCIPAL DIMENSIONS OF W TYPE STIRLING BOILERS IN THE BEACON ST. HEATING PLANT OF THE DETROIT EDISON CO.

Heating surface, sq.ft.	41,500
Number of drums	5
Diameter of drums, in.	54
Length of tube sheet, ft.-in.	27-3
Number of tubes	2,616
Diameter of tubes, O.D., in.	3¼
Height center of mud drums above floor, ft.	18
Volume of combustion chamber, cu.ft.	16,700
Size of double stoker	28 retorts, 29 tuyeres long
Projected grate area, including pit, sq.ft.	636
Inclined grate area, including pit, sq.ft.	679
Continuous coal burning capacity, lb. per hr.	42,800

haust from these sources and the amount required to maintain the feed water at a definite temperature will be made up by a heat-balance turbine, to be described later. Electrical energy for auxiliary drive is distributed by a ring bus circling the building.

Details of Feed-Water System

In the feed-water system shown in Fig. 3, city water under its own pressure flows through the zeolite system into a concrete storage reservoir holding at maximum plant load a three-hours' supply of treated water. Inasmuch as the feed water is taken almost entirely from the city mains, this storage is necessary because of possible interruption of the supply. From the storage reservoir the water is delivered by booster pumps to a head tank, from which it flows by gravity to deaërating heaters supplying the boiler-feed pumps.

The zeolite system of feed-water treatment was selected as being likely to produce a more nearly scale-free water than any other method of treatment. It also has the advantages of eliminating the large hot tanks that are a part of any system of hot precipitation, and its effectiveness does not depend upon accurate chemical control. Freedom from scale is a primary requisite in this plant, owing to the high overloads that will be carried by the boilers and the severe service to which the front tubes will be subjected. The zeolite system is designed on the up-flow principle.

For the ultimate plant of twelve boilers, six tanks, 10 ft. in diameter and 25 ft. long, will be required. Two of these tanks are being installed in the initial section of the plant. A central brine tank and a brine piping system for regenerating the zeolite have been installed.

In the Detroit water supply is a considerable amount of calcium bicarbonate that will be converted by the zeolite to sodium bicarbonate. To overcome the highly alkaline condition in the boilers that would result, a small and carefully controlled quantity of dilute sulphuric acid will be added to the water as it leaves the

zeolite system. The subsequent passage of the water through the deaërating heater will remove much of the resulting free carbon dioxide, together with nearly all the oxygen.

Because of the considerable concentration of salts in the boiler-feed water, the amount of blowdown necessarily will be high, so that a continuous blowoff system has been provided. On its way to the sewer the blowoff water will be passed through a heat exchanger to give up its heat to the feed water.

Coal will be crushed at coaling stations near the railroads, and hauled to the plant by motor trucks carrying drop-bottom buckets that may be lifted from the trucks and emptied into the coal bunkers by a monorail crane operating on a track laid out to reach the several bunkers. The use of this type of crane, with its ability to turn corners, makes it possible to distribute the coal to the bunkers without the use of any secondary means of transport.

Disposal of the ashes has been simplified by placing the boilers at such an elevation that the ash hoppers may be dumped directly into motor trucks.

Model Used to Improve Piping Layout

In designing the piping for this plant, particular care has been taken to present a neat and orderly appearance. Large volumes of fluids to be handled called for piping of large size, and complications arose, owing to the number of piping systems. To assist in the work, the various piping systems, as soon as they had been laid out in the drafting room, were reproduced in a model, using rods of wax to represent the pipes. This method of modeling, previously described[1] in these columns, has proved of inestimable value to the study of the plant design. A typical portion of the model is shown in Fig. 5.

Steam from the plant is conveyed to the network of service mains by feeder pipes carried in tunnels and tied into the service mains at strategic points. These feeders are designed for high velocities. Under maximum conditions the pressure drop from friction may be from 145 lb. (nearly the boiler pressure) to the service pressure of 30 lb. Long-distance gages show the pressure at the remote ends of these feeders. This pressure is kept constant by raising or lowering the pressure in the feeder at the plant end.

One feeder of 16-in. diameter and a 10-in. connection to the service main adjacent to the plant will handle the steam output of the first section. The feeder leaves the plant through a tunnel connecting with the existing system of tunnels, that contains space for several additional feeders.

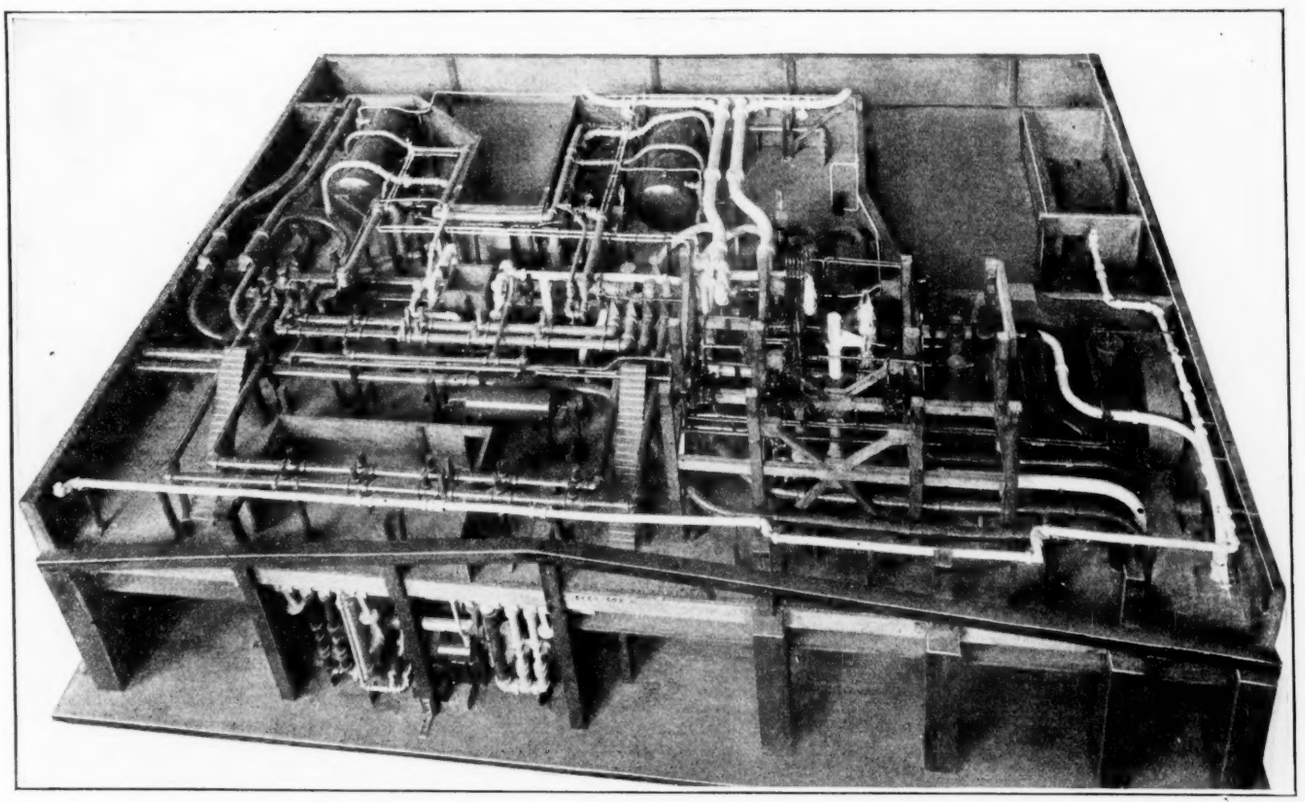


Fig. 5—Models facilitated good piping layouts and eliminated field changes

Turbine Used as Reducing Valve

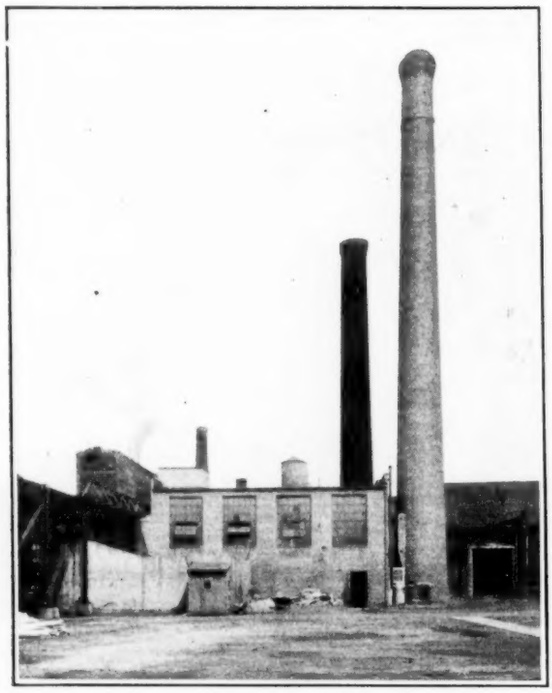
To utilize the pressure drop between the boiler pressure and the feeder pressure for the generation of electricity, the steam going to the feeder first will be passed through a turbine serving, so to speak, as a reducing valve. Mounted on the same shaft, tandem fashion, will be a second turbine which will correct the plant heat balance by supplying sufficient exhaust steam to make up the deficiency between the amount the feed water can absorb and the amount available from other steam-driven equipment. These two turbines will drive a 3,000-kva. alternator that will deliver electricity to the alternating-current bus in the adjoining substation. There will be space in the completed plant for four such turbo-generators.

[1] "Modeling as An Aid in Power Plant Piping Design," by C. T. Van Dusen, *Power*, Feb. 23, 1926.

American Stove Company Revamps Plant

A CONSIDERABLE saving in steam cost has been made by the American Stove Company, Cleveland, as a result of remodeling the boiler plant and installing modern equipment. In the summer of 1925 it was decided to concentrate steam production in the existing central boiler plant and eliminate eight boilers in the five adjacent manufacturing divisions. A new brick stack 125 ft. high was erected and the boiler-house roof was raised. Leaving three old 1,500-sq.ft. water-tube stoker-fired boilers as a stand-by, the fourth boiler (2,500 sq.ft.) was raised to give a furnace height of 9 ft. 6 in. and equipped with a 2,000-lb. per-hour unit pulverizer driven by a 30-hp. induction motor. A new boiler similarly equipped was erected beside it.

In the spring of this year a zeolite water-softening plant and an open feed heater were installed. The latter uses the pump exhausts and a little live steam, thermostatically controlled, to heat the returns to 212 deg., practically, for boiler feed. Other new equipment includes two steam-flow meters, two CO_2 recorders and one steam-pressure recorder. Those responsible for the operation of this plant are M. A. Possons, superintendent; Charles Henderson, chief engineer, and W. M. Davis, assistant engineer.



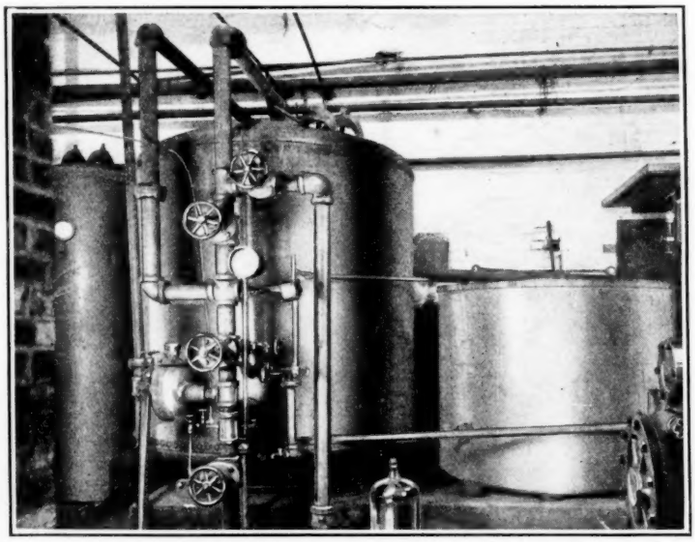


Fig. 1 (upper left)—General view of boiler house showing new stack on the right

Fig. 2 (lower left)—Two 2,500-sq.ft. boilers equipped with unit pulverizers

At left may be seen one of the three old stoker-fired boilers which are held in reserve

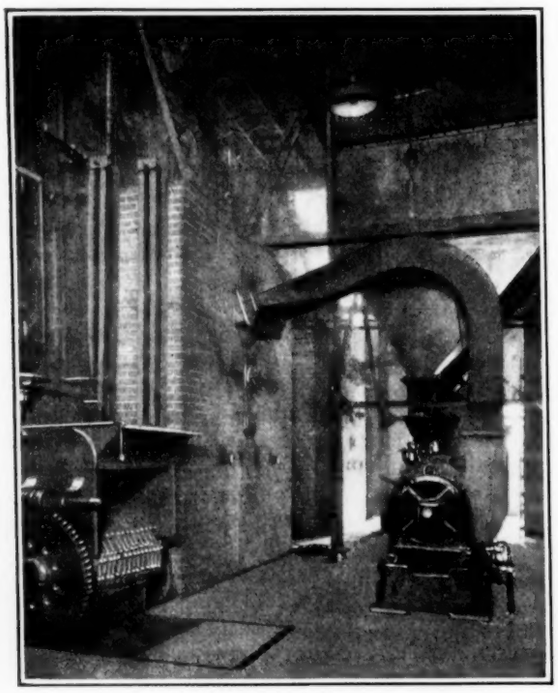


Fig. 3 (above)—Zeolite water softening plant

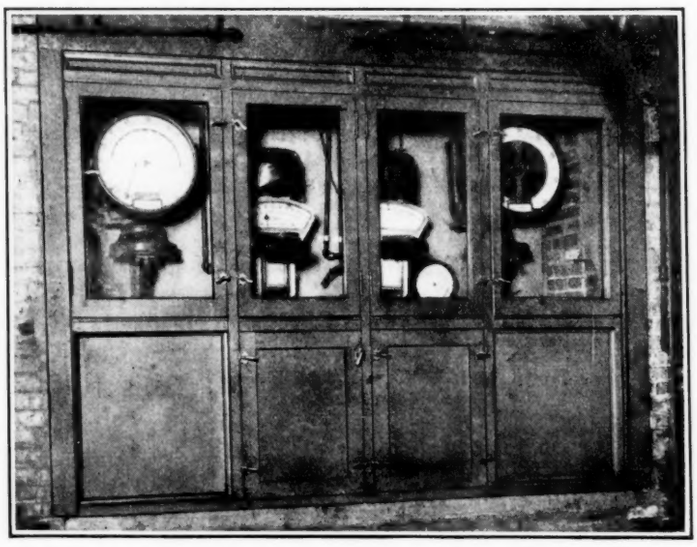


Fig. 4 (below)—Cabinet has glass doors to protect instruments, consisting of two steam-flow meters, two CO_2 recorders (one for each boiler) and a steam pressure recorder

New Lease of Life for the Absorption Refrigerating System

How the Platen-Munters Pumpless System Works—Invention of Two Technical Students Upset Previous Ideas

By G. GROW

THE Platen-Munters absorption refrigerating system is one of the outstanding inventions of the present day, and while now built in small capacities only, there is every reason to believe that ultimately the same system may be adapted to larger capacities. Interesting facts about it are that the system was completely developed into a commercial apparatus within less than four years by two Swedish technical students, B. de Platen and C. Munters, and that within a year after its introduction into this country quantity production has been reached.

The absorption system was the first artificial refrigerating process invented and at one time was more widely used than the compression system, which was developed by Linde. By reason of its apparent simplicity the absorption cycle has long intrigued inventors and manufacturers. Unfortunately, not all of the apparatus has proved commercially successful; this is especially applicable to the liquid pump, which has always been a source of annoyance. Handling, as it does, the strong ammonia liquor passing from the absorber to the generator, operators found it almost impossible to pack the pump piston rod tight enough to prevent leakage without scoring or other damage.

The two technical students abandoned accepted ideas and evolved a system wherein differences in density, together with the presence in the system of a second light gas, induced the flow of strong liquor from the absorber to the generator. A diagrammatical outline of the Platen-Munters system is shown in Fig. 1, while in Fig. 2 is a more accurate representation of the several parts.

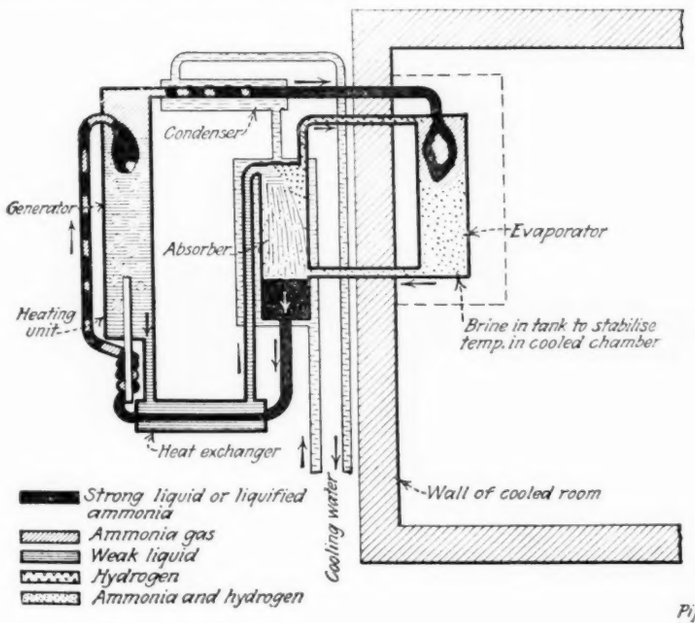


Fig. 1—Diagrammatical outline of the Platen-Munters Siphon

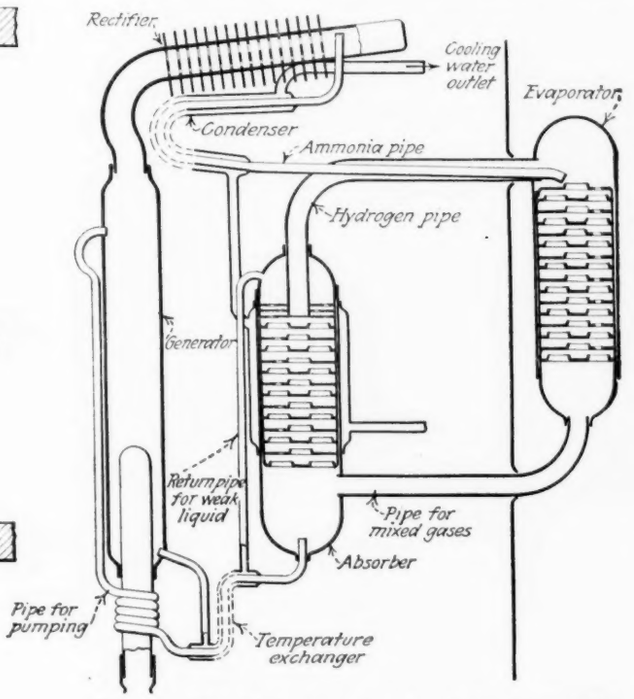


Fig. 2—The Siphon as developed commercially in this country

In the evaporating coils and in the absorber of the usual absorption systems the ammonia pressure is in the neighborhood of 20 lb. gage, while the pressure in the generator is around, say, 150 lb. gage. Obviously, it would be impossible by the application of heat to cause the liquor to flow from the low-pressure region to the generator. The inventors surmounted this obstacle by a recourse to one of the elementary laws of physics—that of Dalton, which may be interpreted as follows: The pressure exerted by a gas and a vapor contained in a vessel is the sum of the pressure exerted by the vapor and that by the gas if each were alone contained in the vessel.

If, then, a gas at, say, 130 lb. be confined in the evaporating coils and in the absorber, the pressure of the ammonia would be 20 lb. as before, but the gage would

register 150 lb. and the generator pressure could still be 150 lb. The total difference in pressure would then be zero, but by heating the density could be decreased to a point where the liquor would flow back into the generator from the absorber.

Simplicity of the Process

The process is simple, and as with so many important inventions, one wonders why the idea was not thought of years ago.

The apparatus comprises the generator, condenser, evaporator, absorber, heat exchanger and thermo-siphon, which are interconnected by pipes. In all portions of the completely and tightly closed apparatus exists the same total pressure. The boiler, or generator, is to a large extent filled with aqua ammonia (the so-called rich liquor), only the upper vapor space of the generator being free from liquid.

Into the bottom of the generator is inserted an electric heating element, connected to a source of electrical energy. From the upper free space of the generator a pipe leads to the condenser, which in turn is connected with the top of the evaporator. The latter is filled with hydrogen gas. At the bottom as well as at the top of the evaporator there is a connecting pipe to the absorber. The absorber is surrounded by a jacket through which circulates cooling water, which then passes to the condenser. From the bottom of the absorber there is a pipe connecting with the top of the generator. This pipe, where it is horizontal, is surrounded by a pipe that passes from the bottom of the generator to the upper space of the absorber.

How the Apparatus Is Operated

The apparatus is operated as follows: Current supplied to the heating element heats the rich liquor in the generator. The ammonia gas expelled from this liquor at a pressure depending upon the temperature to which the liquor is heated, fills the upper space of the generator and flows through the pipe into the water-cooled condenser. Because of the cooling the hot ammonia gases are condensed to pure ammonia liquid. This liquid, which has a pressure approximately equal to that within the generator, say 150 lb., flows to the evaporator. The evaporator is already charged with hydrogen at, say, 130 lb., so that the ammonia will evaporate at a rate such that its pressure added to that of the hydrogen will not exceed the generator pressure of 150 lb. For upon reaching a higher pressure, the flow from the generator would cease. The ammonia gases in the evaporator diffuse into the hydrogen, and the mixture sinks downward, because, as compared to the gas mixture in the absorber, it is heavy. In its downward movement it passes on to the absorber. In this vessel the gas mixture meets with the weak liquor coming from the generator.

The liquid level in the generator is higher than the weak liquor pipe to the absorber; there is, therefore, a continual flow of weak liquor into the absorber. In the absorber the weak liquor absorbs from the gas mixture the ammonia gas and collects at the bottom of the absorber as strong or rich liquid, while the lighter hydrogen free from ammonia ascends and, through the pipe connecting the absorber with the evaporator, again enters the top of the evaporator.

The rich solution is conveyed through the coils of the pipe around the lower end of the heating element and is thereby preheated so that the ammonia gas bubbles form. These bubbles carry along globules of liquid, which thereby reach the upper portion of the generator, and the cycle of operation is repeated.

Outside of the cycle of the ammonia which takes place in all four vessels—generator, condenser, evaporator and absorber—there occurs in the apparatus two other cycles: On the one hand the circulation of the weak liquor from the bottom of the generator to the top of the absorber down to the bottom of that vessel as strong liquor, then to the top of the generator, through the thermo-siphon pipe; on the other hand, the circulation of the hydrogen gas from the bottom of the evaporator to the bottom of the absorber, and from the top of the absorber to the top of the evaporator.

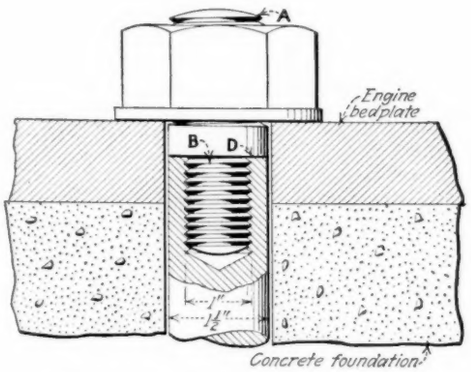
The foregoing description covers the machine as originally designed. The Electrolux Servel Corporation, purchaser of the patents, has developed a machine somewhat different from the original Swedish design. These changes have practically doubled the ice melting capacity of the machine and have greatly increased its efficiency.

Foundation Bolt Repair

By James M. Bloomfield

Some years ago a foundation bolt broke on a horizontal gas engine just below the level of the bedplate, and a means had to be provided to put the broken holding bolt into service again. The repair made, although perhaps not quite so strong as the original, served the purpose very well.

The broken part was removed, the remaining piece



How the broken bolt was repaired

centered and drilled a short distance with a ⅝-in. drill, and the end of the bolt was faced by a counterbore.

The bolt was then drilled with a 1-in. tapping drill to a depth of 1½ in. and was then tapped. A piece of 1½-in. cold-rolled steel was threaded at one end to take a washer and nut, as at *A* in the illustration, and the other end was turned down to one inch and threaded.

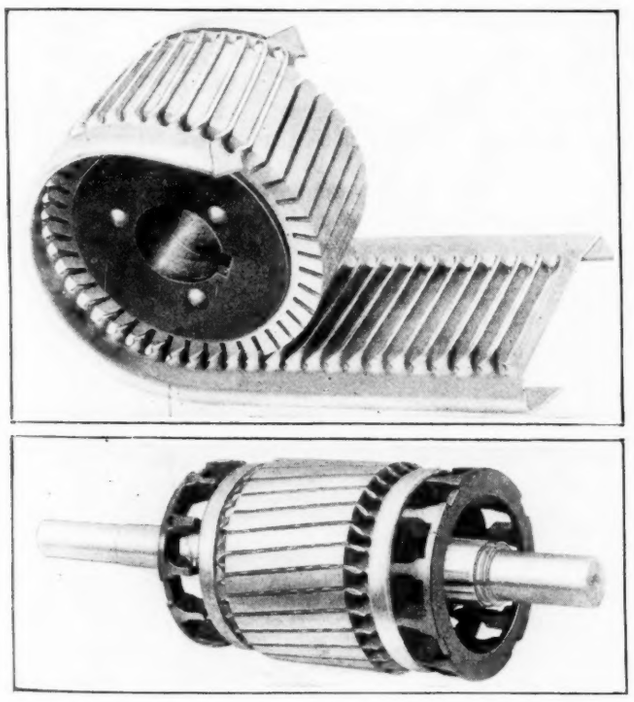
After it had been fitted to the bolt, the threaded rod was withdrawn and the faces at *D* roughened. Some Smooth-on was applied to the thread at *B* and to the face *D*. After it was screwed down, a day was allowed for the cement to set the washer and nut before the nut was put on and tightened up.

Construction of Squirrel-Cage Motor Windings

By B. A. BRIGGS

AMONG the Many Types of Windings Used, Are Those Made of One Piece of Metal, Those that Comprise a Number of Short-Circuited Coils and Others that Have Laminated End Rings. These Are Described and Then the Effects of the Type of Slots and Length of Air Gap on the Operation of the Machine Are Discussed.

MECHANICALLY, the ideal rotor winding would be one made from one piece of metal without any joints. To this end some motor manufacturers have tried casting the winding on the core. Up to the present, this kind of construction has been successful only to a limited extent. Cast-on end rings, or rings connected to the bars by welding processes, are in extensive use, as has been described in previous articles.[1] Using short-circuited coils punched from one piece of metal is a method adopted in a few cases to obtain a winding without joints; in others the whole winding has been punched from one piece of metal. One of the



Figs. 1 and 2—Rotor with a winding made of one piece of metal

prime objects of all these constructions has been to make the rotor winding as near indestructible as possible.

A one-piece winding as used by the Louis Allis Co. is shown in Figs. 1 and 2. It consists of an integral sheet of copper punched and formed by a special mechanical process. The bars are formed by dividing the center section of the sheet into strips and turning these at nearly right angles to the plane of the sheet. As can be seen from Fig. 1, the edges of the sheet are folded over to form the end rings.

After the sheet of copper has been prepared, it is machine wrapped around the core, the bars being expanded into the slots by swaging. In each ring the

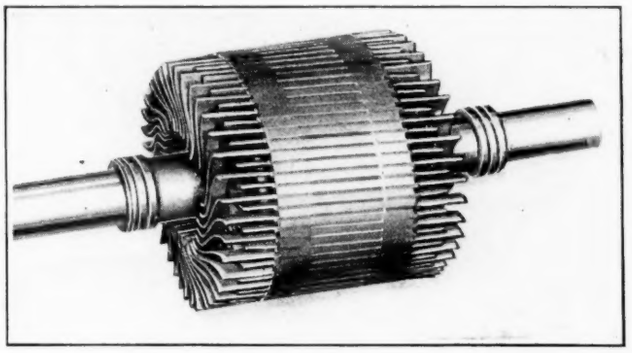


Fig. 3—Rotor with coils made as in Fig. 4

single joint is silver welded, after which the metal of both connections is processed by means of a contracting operation that rehardens the copper at the section where it was softened by the welding heat. Except for the welded joint in each ring, the winding is substantially one-piece, as if it were made from a section of heavy copper pipe.

Contrary to the usual practice of using semi-closed slots in the rotor, in the design, Fig. 1, open slots are used to facilitate putting on the winding. It has been found that so long as a certain relation between the air gap and slot width is maintained, the performance of

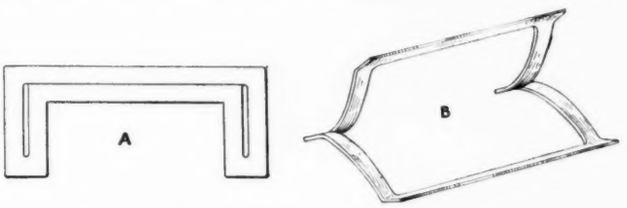


Fig. 4—Involute type of coil formed from a flat piece of metal

the motor does not suffer with respect to power factor and efficiency.

In some types of rotor construction jointless coils are used. One such rotor, as built by Roth Brothers & Co., is shown in Fig. 3. The coils are punched from sheets of copper, brass or aluminum, depending upon the characteristics desired, in a form as indicated at *A*,

[1] August 24 and October 5 issues.

Fig. 4, after which they are pulled to the form shown at *B*.

The slots in the rotor are made of a size in which the coils will fit securely without insulation, and they are also held in place with short non-magnetic steel wedges at each end of the slot, as can be seen in Fig. 3. This gives a winding in which there are no joints or end rings. In many cases the winding is made of alternate coils of copper and aluminum, to obtain the desired

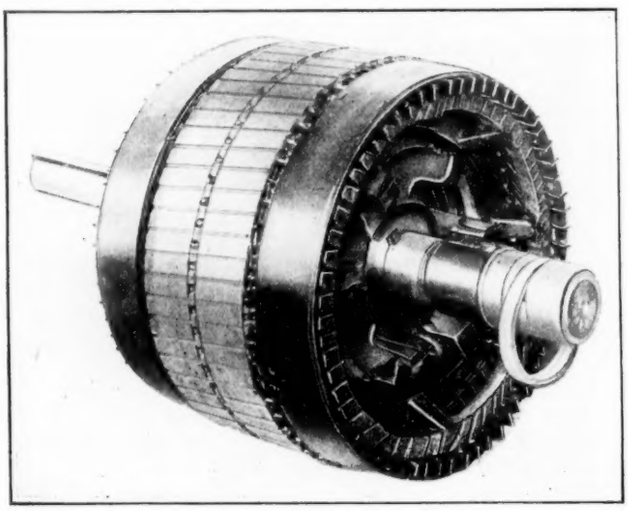


Fig. 5—Rotor with coils made as in Fig. 6

performance of the motor. The protruding ends of the winding act as a fan to circulate the ventilating air through the motor.

The Burke Electric Co. also uses a jointless-coil winding on the rotor, Fig. 5, of its induction motors. The coils are made of copper bars, first cut as shown at *A*, Fig. 6, and then pulled into a diamond-shaped closed coil as at *B*. This construction results in a permanently

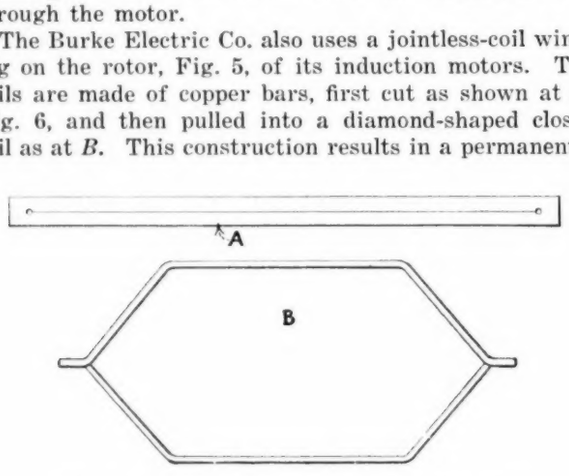


Fig. 6—Diamond type of coil formed from one piece of metal

short-circuited rotor without the use of rivets, bolts, solder or other methods of making the connections between the end rings and bars.

Constructions of rotors described in this and previous articles give a fair idea of the types that are in use, although they by no means cover the whole category. At one time copper laminated end rings were used to a considerable extent, but these have gradually dropped into disuse. In one type holes were punched in the copper laminations slightly smaller than the bars and the laminations forced on the ends of the bars by hydraulic pressure. In this way it was claimed that the contact surfaces of both the bars and rings were scraped clean and a true copper-to-copper contact was formed. A sufficient number of these laminations were used to give the desired cross-section to the ring. After the rings were assembled, the ends of the bars and rings were dipped into a white metal compound which formed

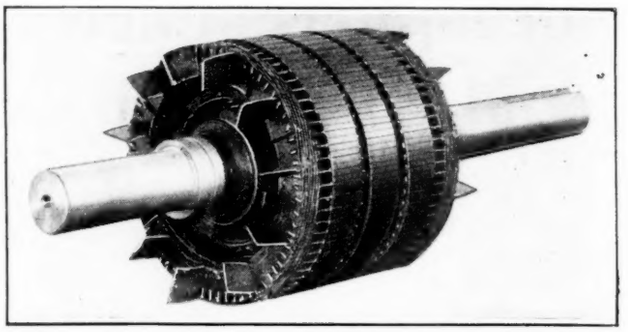


Fig. 7—Laminated end ring assembled to form a spiral

a protective coating to prevent corrosion, but was not intended to carry any current.

In another construction the laminated end rings were made in sections. In assembling, the ends of the laminations were lapped in such a way as to form a helical arrangement of these segments, as shown in Fig. 7. It was claimed for this type of end-ring construction that a better distribution of the current in the laminations was obtained than where the end rings were made of complete rings, since in the latter the inner rings forming a shorter path tended to take more than their share of the current. The type of laminated ring, Fig. 7, offered a certain amount of ventilation to the ring that helped to keep it cooler than the solid ring.

Fig. 8 shows a type of laminated end ring that was

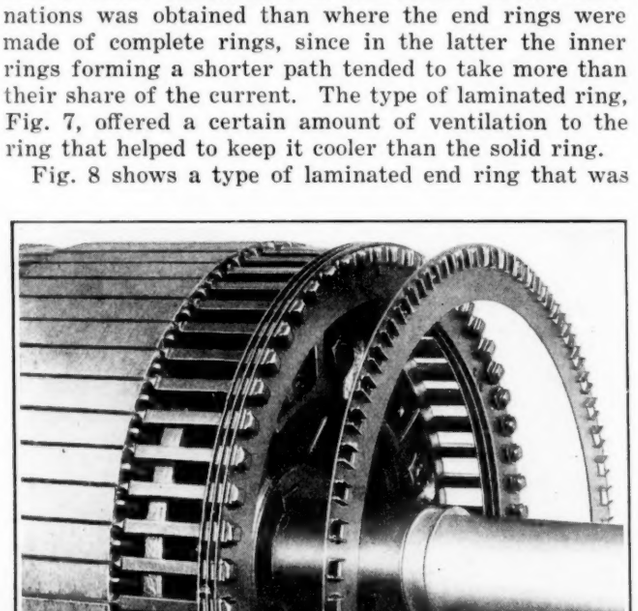


Fig. 8—Laminated end rings built up of continuous rings

formed of continuous thin-copper rings, with an air space between them. These rings were of considerable radial depth and were held apart by projections formed on the rings, when the rectangular holes were punched for the ends of the bars. These projections were formed by dividing in half the pieces that come out of the holes, and bending them out on opposite sides of the

holes, as shown by the separate ring in the figure. The projection also formed a large surface for soldering the rings to the bars.

The semi-closed type of slot is the one that is generally used in rotor cores, although in some cases completely closed slots are used as in Fig. 9, which shows the rotor used by the Linzee Electric Motor Co. It might be mentioned that the fan blades are cast integral with the end rings and then the rings are welded to the bars. It has already been pointed out, open slots are used in the rotors, Figs. 1, 3 and 5. So far as the distribution of the magnetic flux in the air gap is concerned, closed slots are to be preferred, as this would tend to reduce the magnetizing current and therefor improve the power factor. The closed-slot rotor also, as a general rule, makes a more quiet operating motor, because it tends to reduce the flux ripples in the air gap. It is, however, the intention of some of the manu-

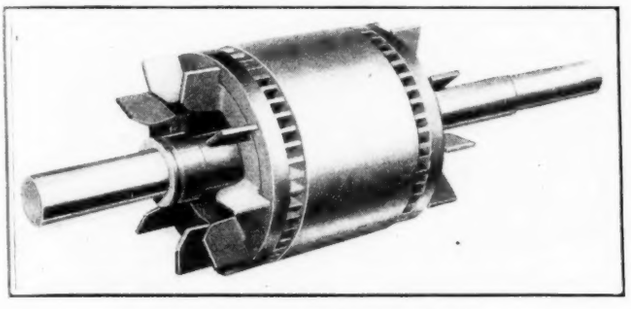


Fig. 9—Rotor with closed slots

facturers who use this type of slot to abandon this construction, as the necessary quietness can be obtained by giving attention to other features in the design.

There is, however, another factor that enters into the rotor's design that tends to offset any advantage gained for the closed slot in setting up the magnetic field. Since the surface of the core is a closed iron circuit, it forms a complete iron circuit around the rotor conductors, which tends to increase the reactance of the rotor and decrease the power factor of the motor. If this bridge over the rotor bars is kept thin, down to a few thousandths of an inch, the reactance of the motor is affected only slightly and does not prevent the designing engineer from obtaining characteristics consistent with a well-balanced design. Where the squirrel-cage winding is cast in one piece, the use of closed slots simplifies to a considerable extent the casting process. Completely closed slots on the rotor have been used only to a limited extent and on small machines, up to about 15 horsepower.

Slots that run parallel with the rotor shaft have been used to a large extent as well as those that are diagonal to the shaft. In the small and medium-sized machines the preference is about equally divided, and in the large machine the slot parallel with the shaft predominates. The reasons for using diagonal slots is to obtain quiet running and to smooth out the fluctuations in the torque.

One of the requirements for a motor having a good power factor is that the air gap be made small. It is general practice to make the air gap on squirrel-cage induction motors about 0.01 in. on sizes of ½ hp. and less, and up to about 0.035 in. for the larger machines. To maintain such close clearances it is necessary that there be no irregularities in the surface of the rotor on stator cores. To give a true surface to these parts, it is becoming common practice to grind them to size after assembling. For the built-in type of motors—that is, motors built in as part of the machine they are driving—the outside of the stator core is also ground.

Tuning Up the Heating System

By Carl Wildey

At this time of year engineers having heating systems are "tuning in" their pumps and heaters and eliminating all the defects before cold weather sets in. Some plants use the hot water in the heating system for circulating water in condensers, but it is an open question as to whether it is good practice to operate a turbine unit at a vacuum corresponding to 180-deg. circulating water, and thus precipitate the alkaline deposits in the cooling water within the condenser tubes. Some recommend that the turbine be run on a high vacuum corresponding to, say, 35 deg. circulating water and furnish bleeder steam from the lower stages to the water heaters.

Salesmen tell us oil from engine exhausts can be completely removed by oil separators, but experience shows us that oil vapors on the outside of the condenser tubes insulate the tubes so that the heat transfer becomes retarded, and the scummy, greasy coating must be eliminated by boiling with caustic soda or some other strong compound before the proper heat transfer can be established again.

Many articles in *Power* have given accurate figures as to loss of efficiency in a boiler due to scale, and the same figures apply with equal accuracy to the heating system. The rust and corrosion caused to mile after mile of 1¼-in. heating system piping by standing all summer, is pumped back to the heater in the Fall, to gum up the tubes and cut down the efficiency of the heater. It is very often the case in large systems, that, owing to appearance, the management have all heating radiators and piping painted to match the rest of the building trimmings. Usually, it is reasoned that the water does not get hot enough to burn the paint off. This is true, for a ⅛-in. coating of paint and the usual dust settlings will so retard the heat transfer in radiators that 200-deg. water will not pass off the heat that tables on heating units show it should. If every engineer would eliminate the oil paints on the radiators, radiation would improve and the coal bill would be passed for payment without the usual curt remark from the manager, "Why all the coal and the factory chilly all the time?"

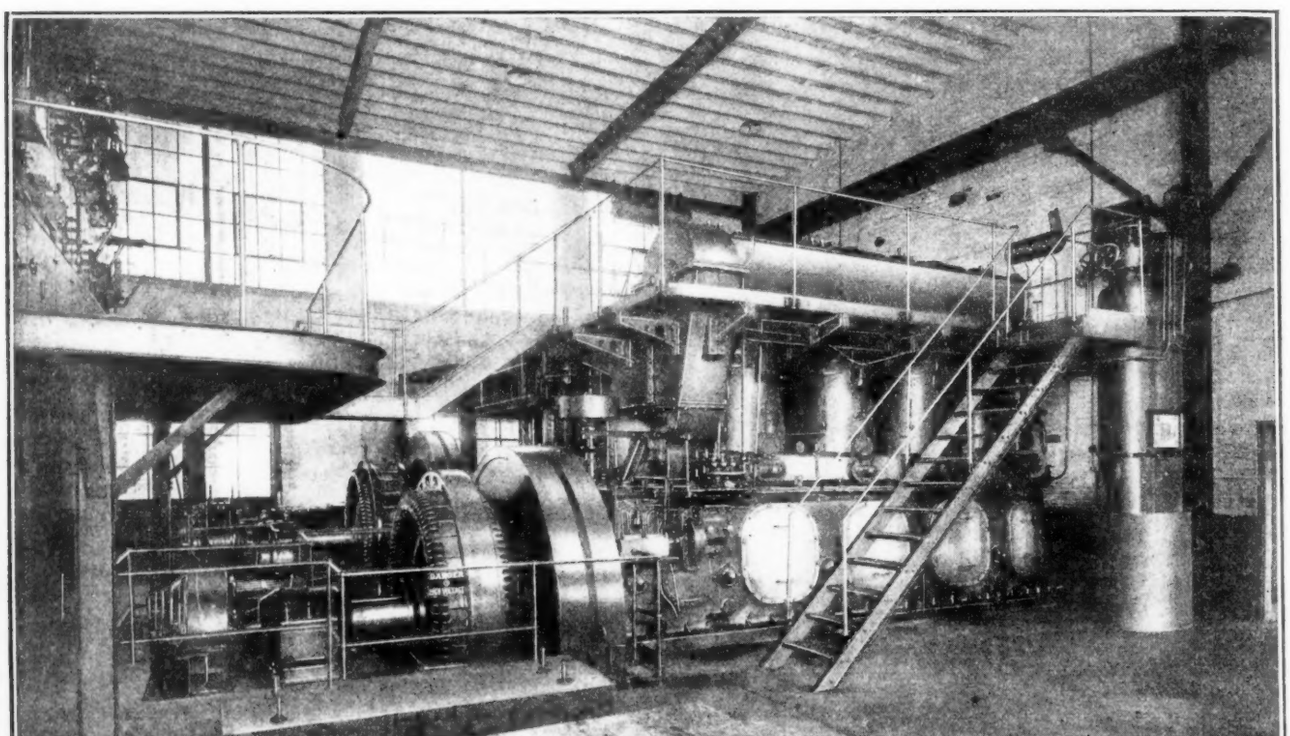
One other very important element in hot water heating systems that must be eliminated, is trapped air. Most centrifugal pumps dislike air with water because they are so constructed that a small amount of air will pocket the water in the impellers until it becomes superheated by the churning and either the impellers seize or the pump fails entirely.

Suitable air traps must be installed in the highest points in the pipe line, as well as vents in the heater and expansion tanks, to permit the automatic removal of air, which is always present where water attains a high temperature, unless a deaërator is used.

Steam at 2-lb. pressure will heat any radiator if the intake and discharge are of ample size, but when they are small, as is usual, that pressure is not enough to push the condensed water into the return line.

An Economic Problem Solved by Diesel Engines

OF THE stations supplying electric energy for lighting and power purposes, about one-half are municipally owned. The great majority of these are small plants, and when powered with non-condensing steam engines using saturated steam, operating costs are usually so high as to prevent the plants from meeting the fixed charges with reasonable meter rates. The solution is frequently the purchase of more economical units, through which the operating saving more than offsets the increased fixed charges.



Horton municipal plant, showing two of the three Worthington Diesels

The power plant of the City of Horton, Kansas, prior to 1921, was steam operated, but because of increasing fuel and labor costs the city found it necessary to provide cheaper power. A Diesel seemed the best solution, and in August of that year a 400-hp. engine was purchased with the proceeds of a $60,000 bond issue.

The steam plant was used as a stand-by to the Diesel engine until January, 1923, at which time a 562-hp. engine of the same make was installed. This was completely paid for from plant earnings within one year after installation, no bond issue being required. During this period a record non-stop run of 201 days was made by this engine. When inspected at the end of the run, it was found to be in first-class mechanical condition with the exception of one damaged spray-valve stem, which caused the shutdown.

Shortly after clearing the indebtedness due to the purchase of the second engine, power and light rates were reduced. This rate reduction, together with the dependable service rendered by the Diesel engines, brought about a considrable load increase, so that a third engine was required. This engine of 600 hp. was placed in service during February, 1926. As in the case of the second engine, plant earnings are supplying the funds.

In addition to this, the power-plant income is sufficient to pay all interest charges and produce a sinking fund to retire $175,000 of outstanding water-works bonds, of which only $98,000 is chargeable to the power plant. The water department is not self-supporting, hence it is only because of the power-plant earnings that the taxpayers are spared a tax to pay interest on and provide a sinking fund for the water-works bonds.

In many cases water works in the smaller towns are made possible only by the existence of light plants, and frequently erroneous bookkeeping permits the water plant to escape proper operating charges.

The official operating record of the plant for 1925 is illuminating, showing a total cost of two cents per

kilowatt-hour, although the plant capacity factor was only 20 per cent.

PLANT OPERATING COST RECORD—1925

Fuel oil, 144,594 gal.	$6,188.67
Lubricating oil, 1,740 gal.	1,251.07
Engineers' salaries	4,360.00
Repairs and extra labor	741.96
One-fourth superintendent's salary (balance charged to water-works and distribution)	750.00
Total plant operating costs	$13,291.70
Total Diesel plant cost	$100,000
Total production, kw-hr.	1,162,518
Plant capacity factor, per cent	20.7
Kw.-hr. produced per gal. of fuel	8.05
Fuel and lubricating oil cost per kw.-hr., cents	0.639
Repair and extra labor cost per kw.-hr., cents	0.064
Labor and superintendence cost per kw.-hr., cents	0.439
Fixed charge cost per kw.-hr.,* cents	0.860
Total cost per kw.-hr., cents	2.002

*Fixed charges figured at 5 per cent interest and 5 per cent depreciation. Maintenance is carried in the operating costs.

ESTIMATED PLANT OPERATING COST RECORD—1926

Fuel oil, 188,000 gal.	$9,400.00
Lubricating oil, 1,800 gal.	1,300.00
Repairs and extra labor	1,000.00
Engineers' salaries	4,360.00
One-fourth superintendent's salary	750.00
Total plant operating costs	$16,810.00
Total plant cost	$150,000
Estimated total production, kw.-hr.	1,700,000
Plant capacity factor, per cent	18.6
Kw.-hr. produced per gal. of fuel	9.04
Fuel and lubricating oil cost per kw.-hr., cents	0.629
Repair and extra labor cost per kw.-hr., cents	0.050
Labor and superintendence cost per kw.-hr., cents	0.300
Fixed charge cost per kw.-hr., cents	0.882
Total cost per kw.-hr., cents	1.861

Estimates show that the cost per kilowatt-hour will be less in 1926 even with an added investment of $50,000, due entirely to the increased load.

This record can be equaled or even greatly exceeded with a higher load factor, in any efficiently managed Diesel plant having engines that have been proved by field service to be correctly designed.

Largest Single-Unit Automatic Hydro-Electric Station

What is to be the largest single-unit automatic hydro-electric generating station in this country, and probably the world, is being erected on the Elwah River, 11 miles from Port Angeles, Washington, by the Northwestern Power & Light Co. This station, to be known as the Glines Canyon power house, will furnish power for the operation of the Washington Pulp & Paper Co.'s plant at Port Angeles. It will probably go into operation early in 1927.

A single arch dam is being constructed approximately 190 ft. high, forming a reservoir that will impound about 40,000 acre-feet, the draw-down from about half of which will be used in generating electricity. The power house will be approximately 800 ft. downstream from the dam and on the western bank of the river at the mouth of a gorge. The water will be conducted from the dam to the power house in a tunnel 575 ft. long.

The generating equipment will consist of a 17,500-hp. vertical-shaft, Francis turbine furnished by the Pelton Water Wheel Co., driving a 13,333-kva. alternating current 6,600-volt three-phase 60-cycle 225-r.p.m. 90 per cent power factor generator with direct-connected exciter. This generator and all the other electrical equipment will be of General Electric manufacture, including three 4,500-kva. outdoor-type transformers and necessary switching equipment.

Both the main unit and a 62.5-kva. auxiliary water-wheel and motor-driven oil pump unit will be controlled by the automatic equipment. By means of selector supervisory equipment the operator at the Elwah station, seven miles distant, will give starting and stopping indications to the automatic control equipment which, in turn, will perform all the necessary operations for starting, stopping and protecting the main unit and applying field to the generator. The unit having been started, the operator at Elwah will adjust, by means of the supervisory control, the voltage and speed of the unit and synchronize it with the system across the circuit breaker in the Elwah station.

Supervision over the load assumed by the generator at Glines Canyon will be given the operator at Elwah by the supervisory control and this control will also indicate the position of the waterwheel gates. The main generator will be equipped with a voltage regulator which will control the voltage after the unit has been connected to the system.

The auxiliary unit will consist of a 62.5-kva. 220-volt 60-cycle three-phase synchronous machine with direct-connected exciter, an oil pump and a Pelton waterwheel. When the main unit is shut down, the auxiliary machine will act as a generator, and will furnish power for station lights and auxiliaries, being driven by the waterwheel which will also maintain oil pressure. When the main unit is started, the auxiliary machine will be connected to the main generator and, running as a motor, will furnish oil pressure, the governor on the auxiliary wheel automatically closing the wheel gates as the motor assumes the load. An emergency motor-driven oil pump will also be provided, starting up automatically when the oil pressure falls below a safe operating value.

The Glines Canyon power development is being designed and constructed by Thebo, Starr & Anderton, Inc., of San Francisco.

In the September 14 Issue, under the title, "A Bleeder Type Steam Engine," there was described the new Chuse engine employing selective exhaust, and the statement was made that "several of these engines have been installed in various industries." Subsequent information has shown this statement to be in error. Only two out of three engines were equipped with selective exhaust. That for the University of Missouri tested out satisfactorily on the block, but it later developed that the appropriation for the condensing equipment at the University plant was not forthcoming, and as a result the engine is at present running non-condensing. The second engine went to Memphis, Tenn., but the purchaser decided later not to install condensing equipment, and the engine is operating at present with one block of three cylinders exhausting to the atmosphere, while the second block is connected to the back-pressure system.

Where It Is Necessary to Weld a number of small nipples into a pipe or header, a plan that is sometimes used is to bend the pipe so that there is a sag, or depression, of about $\frac{1}{2}$ in. in a 10-ft. length. The nipples are then welded in on this side. If the pipe has been bent too much, it will be necessary to heat the side away from the nipples and to cool it with water until it has straightened out. Where only two or three nipples are to be welded into a length of small pipe, some welders merely heat the far side, after cutting in the holes for the connections.

Notes on the
Sampling of Boiler-Flue Gases

By CHARLES GARRETT THATCHER
Assistant Professor of Mechanical Engineering, Swarthmore College

HOWEVER expert the analysis of flue gas, the result cannot be better than the sampling. The percentage of CO_2 in a flue may easily range from 10 per cent near the walls to 15 per cent at the center. This being the case, careful attention to sampling methods is essential if CO_2 readings are to have much value. To find out the actual conditions for several standard types of boilers, the author has carried on an extensive practical investigation. The results are here presented in a form that will be helpful to engineers confronted with this problem in their own plants.

THIS article deals with the matter of obtaining a representative sample of flue gas, particularly with respect to its CO_2 content, from steam boiler passages.

A test engineer who inserts his gas-sampling tube into the center of the last pass of the boiler and obtains a true sample of the flue gases for a particular moment, is indeed fortunate. For it would seem that the time-honored locality, the center of the last pass, though it might by accident yield a true average sample, generally will not, but will show a higher percentage of

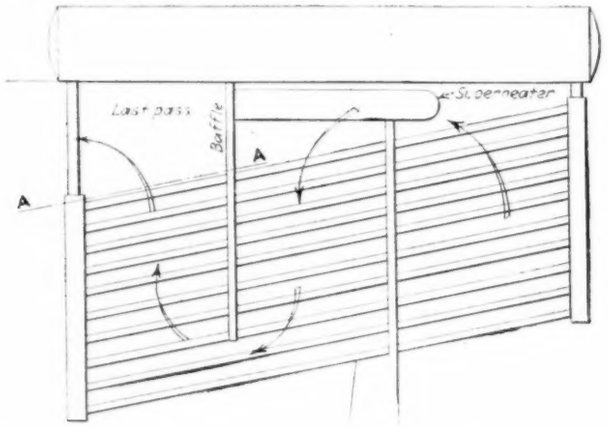


Fig. 1—Horizontal water-tube boiler (10,000 sq.ft.), showing plane AA on which gas samples were taken

CO_2 than the true average. In nearly every instance the largest loss in boiler operation is that in the dry chimney gases.

It is evident that the result of the calculation of this loss can be correct only when a sample is obtained that is representative of the whole volume of gas at the particular moment. In a rough calculation of dry stack loss CO_2 alone may be used, leaving the other components out of consideration. The CO_2 content is generally considered a valuable index of the efficiency of combustion except for refined tests where O_2, O and CO are also determined.

Are your CO_2 meters and recorders telling you the average percentage of CO_2 in the gas as a whole? They are not if they draw a sample from the center of the last pass, as is most usual. But what difference does it make? Is not the whole volume of gas of nearly the same analysis throughout?

With these questions in mind the writer believed it worth while to explore with a sampling pipe and Orsat

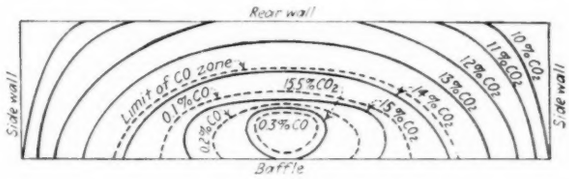


Fig. 2—Occurrence of CO_2 and CO in samples taken along plane AA (Fig. 1). Boiler operated at 120 per cent rating with underfeed stoker

apparatus into the gas passages of several types of boilers with the idea of determining if possible the true average CO_2 content of the gas flowing past an imaginary plane perpendicular to the direction of gas flow, and of relating the CO_2 at the center of the plane to this average.

The experimenting was done on several different types of boilers and often on several boilers of each type, so as to make it as representative as possible. In general the method consisted of making a CO_2 survey at the last pass of the boiler, as on plane AA, Fig. 1, using an Orsat apparatus for analysis. The sampling tube was introduced at various well-defined stations.

The results of a great number of readings on a 10,000-sq.ft. horizontal water-tube boiler, operated with a constant rating of 120 per cent, are illustrated in Fig. 2. These boilers are fired with a good grade of Eastern bituminous coal by underfeed stokers.

It must be recognized immediately that there are several factors which cause the occurrence of CO_2 to be quite variable in different boilers and even in the same boiler at different times. Fire conditions, of course, have a great deal to do with this. The state of the grate and furnace walls, baffles, and side walls of the boiler also have a great effect, because of their control of the primary and secondary air supply. It is altogether conceivable, for example, that in a boiler whose side walls were in very bad condition, the percentage of CO_2 next to the wall might be 5 per cent instead of 10 per cent, as shown in Fig. 2, or that in an extremely tight boiler the variation across the last pass might be much less than for the case shown.

The data here shown represent readings taken on several boilers in good average condition. However, it is certainly true that whether the variation in CO_2 across the pass is great or little it will follow the same

general type of curve, and the problem of determining the representative gas sample is pretty much the same. An exceptional case might be cited, where one side of a boiler is in much worse condition than the other, causing the CO_2 curve to be unsymmetrical. In a tight boiler there is much less chance to make a serious error

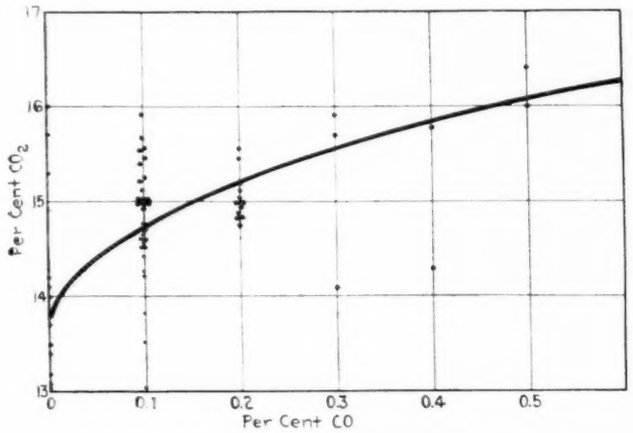


Fig. 3—Relation between the occurrence of CO_2 and CO in Fig. 2

in obtaining a representative gas sample, aside from fire conditions.

Unevenness in the fire-bed makes it more difficult to obtain a true sample. These irregularities in the fire-bed are bound to occur, and therefore a great number of readings covering a considerable period of time, or continuous readings, such as those taken by recording instruments, are necessary in order to even up these irregularities due to the fire. In the type of boiler illustrated in Fig. 1, there is a strong tendency toward infiltration of air at the back. This shows up in lower

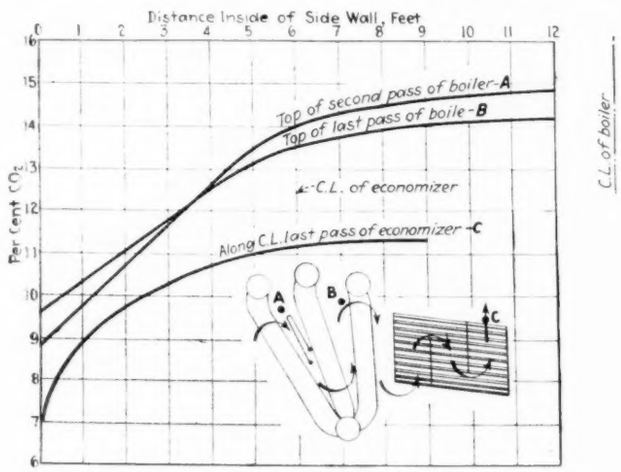

Distance Inside of Side Wall, Feet
0 1 2 3 4 5 6 7 8 9 10 11 12
Per Cent CO_2
Top of second pass of boiler-A
Top of last pass of boile-B
C.L. of economizer
Along C.L. last pass of economizer-C
C.L. of boiler
A
B
C

Fig. 4—Occurrence of CO_2 in flue gas of 15,000-sq.ft. Stirling-type boiler operating at 180 to 200 per cent rating with underfeed stokers and separately housed economizer

CO_2 and temperature and in higher velocity of the gases near the back wall. The high CO_2 zone and the CO area are at the front center of the pass, the colder influx of air clinging to the back wall and passing below as the gases flow out through the breeching.

In Fig. 2 it will be noticed that an attempt has been made to show a limited CO area. This is another extremely variable thing, and its occurrence cannot be counted upon. Fig. 3, showing the relation between CO and CO_2 in this type of boiler, however, indicates in general that with 14 per cent CO_2 there is no CO, that with 15 per cent CO_2 the CO is around 0.15 per cent, and that with 16 per cent CO_2 the CO is of the order of 0.5 per cent.

In Fig. 4, instead of taking analyses over planes, CO_2 readings were taken simply along lines as shown at *A*, *B* and *C*. The resulting curves show the dropping off of CO_2 near the boiler wall in all three cases

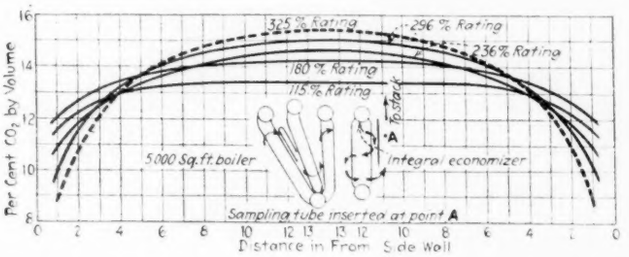


Fig. 5 — Variation of CO_2 with per cent of rating. Samples taken along center line of last pass. Boiler 5,000-sq.ft. Stirling type with integral economizer and underfeed stoker

and the dropping off in the average CO_2 as the gases progress through the boiler and economizer. The sketch showing the path of the gases is diagrammatic only and does not show the fact that the economizer lies at right angles to the boiler. Thus the gases in this case have a rather long and winding path, involving great opportunity for infiltration of air. It will also be noted that this long passage of the gases has a tendency to mix them thoroughly so that the CO_2 at a point three feet inside the side wall of the economizer is a much greater percentage of the CO_2 at the middle than is the case in the early passes of the boiler.

To show the effect of different ratings of a boiler on the CO_2 variation, a series of readings were taken on a 5,000-sq.ft. Stirling-type boiler with integral economizer.

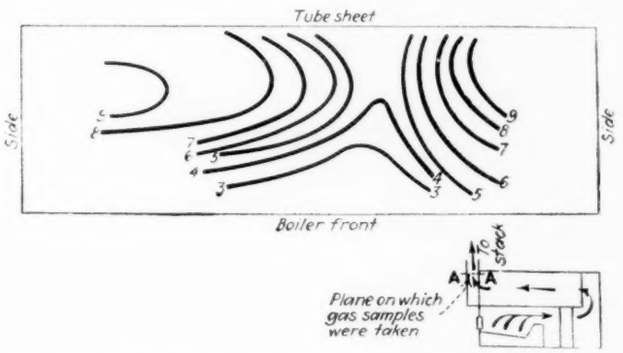


Fig. 6—Variation of CO_2 in boiler front of 1,250-sq.ft. return-tubular boiler. Lines represent constant percentages of CO_2 as indicated

The readings were taken along the center line of the last pass of the economizer. It will be noted that for the low ratings the curve is rather flat, as shown in Fig. 5, but at the higher ratings much lower readings of CO_2 are obtained close to the side wall and considerably higher percentages at the center of the pass. This is explained partly by the fact that at high ratings the draft is greatly increased, causing more infiltration

through side walls and doors, while at the same time the fire-bed is heavier, causing a higher percentage of CO_2 at the center and in fact a higher average percentage clear across. Another factor is the secondary air supply through side-wall air blocks in this boiler. This air, being dependent on the wind-box pressure, causes high excess air at the sides when the rating is increased.

Work of this kind on horizontal return-tubular boilers is not done to such an extent, but the author took the

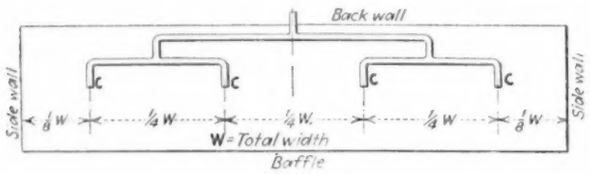


Fig. 7—Sampling tube on horizontal plane in last pass of boiler

trouble to make a survey in the boiler front of a 1,250-sq.ft. hand-fired boiler of this type, using No. 2 buckwheat coal. The results are shown in Fig. 6. The conclusion that may be quickly reached from this diagram is that the boiler front doors were not properly sealed and that there was a great deal of infiltration between the doors at the center. It is probable, however, that this condition is all too frequently met with in small plants, and it is evident that it is no easy matter to obtain a representative sample of gas under such conditions.

A method for obtaining a fair sample of gas such as is illustrated in Fig. 7 has sometimes been tried. In this case, where it was used in the 10,000-sq.ft. horizontal water-tube boiler shown in Fig. 1, the openings *CC* were along the center line and at points ⅛, ⅜, ⅝ and ⅞ of the distance across the last pass from the side of the wall.

Results Check Closely with Calculated Averages

It was found from 48 readings, all taken at approximately 120 per cent boiler rating, that the results obtained checked almost exactly with the computed average CO_2. It was also found that in this set of boilers and at this rating the calculated average CO_2 was about 90 per cent of the reading at the center of the last pass. It was further determined that a reading taken by introducing a sampling tube about one-fifth of the way across the center line of the last pass from the inside of the side wall would give the same result as the calculated average.

At a decidedly different rating of these boilers these conclusions would not hold, but as this particular set of boilers happens to be operated at a nearly constant rating, the conclusions are believed to be all right in their case. A decidedly erroneous result might be obtained from a sampling tube put in one-fifth of the way across the pass, on account of fuel-bed conditions. This also applies to the center of the last pass or any other one point. The center is likely to give better results as a basis for the true average. This is because fires often run for a long period considerably heavier on one side than on the other, with the middle about average. However, it is the writer's opinion that sampling at only one point is bad practice, because the chances of that sample being representative of the whole are very small indeed.

The question naturally arises, How do these methods of sampling for CO_2 take care of the CO? Obviously, the method of going in from the side one-fifth of the way across the pass, will not give any indication of the true CO, if it shows any at all, referring back to Figs. 2 and 3. The sampling tube of Fig. 7 would show a trace of CO, but probably not enough for a true average.

CO Samples from Large Number of Points Give Truest Results

By volume CO is difficult to determine—and its occurrence quite variable. It therefore seems almost useless to press the matter of its very accurate determination. Boilers with larger furnace volumes do not have as much CO, and errors involved in approximating the true average would be smaller. While the distribution of CO across a pass in a certain boiler may be far more even than that shown in Fig. 2, it is such a small and uncertain quantity, and also so likely to occur only at certain points (owing to the gases being stratified), that sampling at only one point will lead to worse errors than is the case with CO_2. Therefore, in determining the average CO in the gases, the best way is to take samples from a considerable number of points across a plane.

The type of sampling tube illustrated in Fig. 7 was also introduced into a 15,000-sq.ft. Stirling-type boiler with integral economizer. The tube was put in the last pass of the economizer. This boiler is operated over a wide range of ratings. In Fig. 8 curve *A* shows the average CO_2 taken at the center of the economizer last pass for various boiler ratings, *B* shows the calculated average from readings taken over the last pass, and *C*

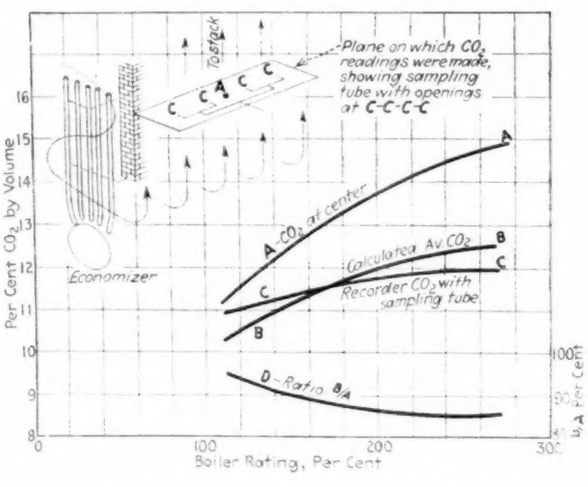


Fig. 8—CO_2 relations for last pass of 15,000-sq.ft. Stirling-type boiler with integral economizers

shows readings taken from the experimental sampling tube similar in proportion to that shown in Fig. 8. It is evident that the sampling tube gives fairly accurate results within the range of 140 to 240 per cent of rating, which is the usual range for these boilers, but that the sampling tube gives a reading a little too high at the lower ratings and a little too low at the higher ratings.

This can be explained by the fact that the samples at the four openings are given equal weight, but that the draft conditions are such when operated at high rating that the openings nearest the side walls draw a sample that is considerably leaner than the average. At low

ratings, on account of the flatness of the curve of variation of CO_2 across the pass, the four openings draw samples of nearly the same analysis, and the side-wall condition does not enter in to a sufficient extent to bring the sample down quite to the true average.

Such a device as this could be proportioned so as to give practically a true average at any given rating, but not for all ratings. In the instance cited, however, it is evident that no great error would be introduced by using the sampling device in proportions shown in these boilers at their usual ratings. In any event it would be

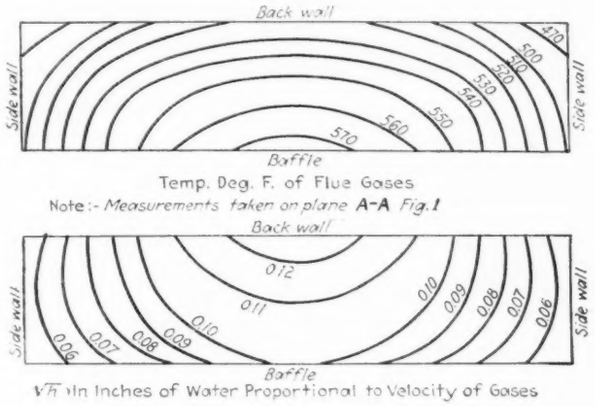


Fig. 9—Variations in CO_2 and gas velocity along plane A, Fig. 1

much more accurate to take readings from this device than from a single sampling tube at the center of the pass.

To approximate closer the CO_2 average across the pass of such a boiler, a sampling tube with eight equally spaced openings, instead of four, suggests itself. This is a somewhat unwieldy contrivance but should give satisfactory results. The use of a sampling tube with four equally spaced openings, as illustrated in Fig. 7, but with the outside openings slightly smaller than the inside, might prove somewhat more accurate, since it would give a little less weight to the samples taken near the wall. When using tubes with more than one opening, provision for blowing out the soot should be made. To make the blowing positive, the pipes to each sampling point might better be separate, each with its own connection for blowing, and joining into a common header outside the boiler wall.

In computing an average CO_2 content for a certain plane, all gas-sampling stations on that plane should not be given the same weight since the velocity of the gas varies and also the temperature. In order to find out the variation in temperature, a considerable number of readings were made with a thermocouple and pyrometer in the last pass of a horizontal water-tube boiler, as shown in Fig. 1. To obtain an indication of the variation in velocity, a pitot tube was inserted and readings made on a differential draft gage. The pitot tube had two branches, one projecting upstream and one downstream, and therefore the reading on the draft gage was twice the velocity head expressed in inches of water. Determining the square root of h gave a value proportional to the velocity at the various points in the plane. Fig. 9 shows the results of these experiments in determining temperature and the square root of h.

A weight factor was worked out for each station in the plane, this factor being the square root of h divided by the square root of T, where T is the absolute Fahrenheit temperature. The weighted average CO_2 is 13.105, while the simple numerical average of CO readings for the plane is 12.95. Nothing about the whole proceeding warrants making this attempt at an extremely accurate CO_2 average, although it would generally be found that the weighted average, since it gives more weight to the stations near the middle of the pass where the velocity and CO_2 are both higher, would be higher than the numerical average. In case the setting were in bad condition and the CO_2 near the walls fell away off, this difference would be greater.

In working out weighted CO_2 averages for the two other types of boilers shown in Figs. 4 and 5, the writer left temperature out of consideration and used only the square root of h as a modifying factor. The same conclusion was reached as before, namely, that the weighted average was very close to the numerical average and that the effect of varying velocities and densities across a pass in a boiler should not be considered.

Water-Power Developments Making Rapid Progress

It was stated in last year's report of the Federal Water-Power Commission that the preceding four years had witnessed the greatest water-power development in our history, and that it could scarcely be doubted that one of the primary factors in this development had been the Federal Water Power Act, under the terms of which there had been offered for the first time conditions safeguarding the large investments required. This conclusion is fortified by the experience of the last fiscal year, during which construction was started upon twenty new projects which will have, when completed, an installation of 1,220,000 hp., or 40 per cent of the total placed under construction during the preceding five years, as given in the sixth annual report of the Commission.

Among these new projects are the 180,000-hp. Lock No. 18 development of the Alabama Power Co. on the Coosa River, Ala., the 135,000-hp. combined power and navigation development at the Falls of the Ohio, Louisville, Ky.; the 473,000-hp. Conowingo development on the Susquehanna River in Maryland and Pennsylvania; and five projects in California, aggregating 417,000 hp. These projects bring the total of plants placed in operation or under construction, under license of the Commission since July 1, 1920, to 3,900,000 horsepower.

Of the 726 power applications filed with the Commission up to July 1, 1926, 523 were for major projects. Of the latter number 250 have been cancelled or withdrawn, leaving 273 in active status, with a capacity of proposed installations of 24,750,000 hp. The Commission has issued 389 permits or licenses. Many of the permits have been succeeded by licenses, others have expired without the filing of applications for license, and some have been cancelled for failure to comply with their terms. A considerable part of the total number of licenses is for minor projects. For major projects 137 permits and licenses are outstanding with an aggregate of 10,100,000 hp., leaving 136 major applications with a total of 14,690,000 hp. still awaiting action. The Commission has been able, therefore, in the six years of its administration, to keep current the large number of minor cases, to weed out a considerable number of speculative applications, and to dispose of approximately one-half of the applications of primary importance.

Removing Coils from Armatures Without Injuring Them

By C. O. Mills

BEFORE it became the practice to impregnate the windings of electric machines with insulating varnish after they were placed in the slots, as many of the old coils as possible were salvaged if it became necessary to rewind the machine. This, however, was a somewhat doubtful practice, for no matter how carefully the coils were taken out of the slots, there was always the danger that the insulation would be injured on the inside of the coil where it could not be seen. These coils might show up well under test, but, when they were in service a short time, would fail owing to current leaks or other causes.

In some repair shops, unless the coils came off in exceptionally good shape, no attempt was made to save them, as it was felt that they had too much of an element of risk in them to take a chance with. No doubt failure of many machines, shortly after they had been rewound, was due to using the old coils that had been removed, cleaned up and put back on the armature.

The practice of impregnating the whole winding with insulating varnish after it is in place and then baking, has made it more difficult to remove the coils without injuring them for a rewind job. If the cost of new coils is balanced against the possibility of having to rewind the machine again in a short time if the old ones are used, the additional expense for the new coils will in most cases be a good investment. The increase in time required in trying to remove the coils in good shape and putting them into condition to be used again, will go a long way toward paying for a new set of coils.

More than once a lot of time has been spent in trying to remove a set of coils, with the intention of saving a large part of them, only to throw them away and use all new ones, as the condition of the old ones precluded their use again. Where the coils do not have to be used again, the armature can be stripped in a small fraction of the time required if they are to be saved for rewinding.

Insulation Affected by Age

The age of coils and the temperature at which they have operated are factors in the condition they will be in when taken from the slots. If they have been in use for a long time, the insulation will have become brittle, and it will be almost impossible to get them out of the slots without cracking and injuring the insulation. When coils have been in use for a short time, the insulation has not become brittle and will stand considerably more bending without serious injury.

Where coils have been impregnated in the slots, their removal will be made easier by first heating the winding, which can be done by passing a current through the coils or by heating in an oven. In some cases the core has been heated with a torch, but this should be done before the retaining wedges are removed, to avoid injuring the coils, if it is intended to salvage them for the rewind job. Heating the coils with an electric current is probably the best method, as it insures that the insulation on the inside will be heated and made flexible to stand better any bending they may be subjected to during the removal process.

Another method is to soak the winding in gasoline for about 12 or 15 hours. With a direct-current armature only the winding should be submerged, which means that the armature must be stood on end in the gasoline with the commutator above the surface. When this is being done, care must be exercised not to use an open flame in the presence of the vapors that may be present. To lift the coils, a long slim fiber wedge that can be driven into the slot below the coils will be found helpful.

Using Varnish Remover on the Coils

Attempts have been made to use varnish remover to release the coils in the slots. A number of these varnish removers are on the market, but they must be used with discretion, as they may have a deleterious effect on the coils' internal insulation.

What has been said in the foregoing applies to small and medium-sized machines with open slots, that have form-coil windings, wound with a number of turns of wire. On large machines with bar windings, if the coils are removed they are thoroughly cleansed of the old insulation and reinsulated.

On machines that have semi-closed slots or are hand wound, there is only one solution to the rewinding problem, and that is to get the old coils off the easiest way and put in a new winding.

Where one or two coils are injured in the winding, it generally is possible, with form-coil windings in open slots, to lift the top sides of the coils necessary to remove the faulty coils and replace them, without injury to the side of the coils lifted. The lifting of the top sides of the coils can be facilitated by first disconnecting their top leads from the commutator, then passing a current through these coils to heat them before attempting to lift them from the slots.

There is more or less danger of injuring any coil when removing it from the slots. If this can be avoided by cutting the faulty coil or coils out of the winding, there is much to recommend the practice. Most windings will operate satisfactorily with one or two coils cut out. When the job is done properly, the insulation of the winding may be in better condition than if the top sides of some of the coils were lifted and the faulty ones replaced.

Considered Upon a Potential Quantitative Basis, the most important latent resource of fuel oil is our oil shales, according to James O. Lewis in *Compressed Air*. These exist in enormous measures in both the eastern and the western parts of the country. Oil shale resembles a poor grade of cannel coal; and to obtain the contained oil it is necessary to mine, to crush, and to retort the shale. The quantities of oil in such shale deposits are vastly greater than the amounts of petroleum in our oil sands. Even so, the exploitation of our oil shales will require an immense sum of money and involve much time to develop satisfactory extraction methods and to install equipment of sufficient capacity to supply enough oil to meet any large share of our needs. Oil from oil shales will be available shortly, but in relatively small quantities; and the output will gradually supplement our other sources of supply as the technique is developed which will render practicable the commercial extraction of this oil on a suitable scale. Oil from these shales will be relatively but not excessively high-priced oil.

Saving Money with Models

ON ANOTHER page of this issue is a description of a new central heating plant in Detroit, and it is there stated that models were made of the entire piping layout of this plant during the design period.

There is an inclination among some engineers to sniff at an innovation of this nature as being an expensive frill. Some have stated that it is merely a substitute for intelligent blueprint reading.

In refutation of these attitudes and criticisms, it appears that in this particular instance the few field changes required were confined to electrical conduit and other piping too small to be included in the models.

Power believes that the complete absence of field changes and corrections in main piping is a record without precedent.

Apparently, the making of a model pays for itself handsomely. Perhaps it may become a regular practice in drafting rooms handling complicated installations.

A Masterpiece of Research

IT IS one of the ironies of fate that out of the War, which so nearly wrecked our civilization and which has resulted in the prolonged economic agony of many nations, have sprung not a few real aids to mankind in its struggle upward. Surgery and medicine, faced by disease, wounds and mutilation, devised almost overnight new methods of plastic surgery, of antiseptic technique and of diagnosis. Chemistry developed the gas mask, now useful in mines. Physics produced new instruments.

Germany, hemmed in by her enemies and forced to live and fight without imports, kept her scientists busy developing synthetic substitutes for essential raw materials not found in that country. Out of this came results that promise now to benefit her former enemies, as well as herself.

An outstanding example is the process of coal liquefaction developed by Dr. Friedrich Bergius and described by him in some detail at the International Conference on Bituminous Coal, held last week in Pittsburgh. It should be clearly understood that this is not a process of distillation, but one in which the solid coal, both volatile and fixed carbon, is actually liquefied.

Doctor Bergius' work on this process began back in 1912, but was pushed intensively all during the War, since it promised a supply of liquid fuel without petroleum.

His paper is briefly abstracted in this issue. The complete report will appear later in the printed proceedings of the Conference. Those who heard him deliver his address were impressed with the novelty of the whole proceeding, as well as by the practical possibilities of the perfected process.

Space does not permit a discussion of the details of the process, but one can visualize the difficulties in building containers, pumps, valves, etc., for pressures of 3,000 pounds and temperatures 600 to 900 degrees Fahrenheit. In addition, there is the difficulty of controlling the process, and the power consumption, which seems to be high. The experimental cost has already run into several million dollars; an average of one hundred and fifty men have been employed on the project for a number of years. Two plants are now to be constructed in Germany with a combined capacity of one million barrels of liquid products per year. If this functions as predicted, it will crown one of the most masterful pieces of research of this generation.

The Dust Explosion Hazard

THE finer a combustible substance is comminuted, the more surface it presents for oxidization, the faster, within limits, is its combustion. If it is fine enough and the atmosphere is permeated with it to the required degree of concentration, the rate of combustion becomes explosive.

Coal shares this property with other combustible substances and is no more dangerously explosive than the rest of them. Not only easily combustible organic materials but metallic dusts have added to the record of disastrous explosions.

In a recent address before the National Safety Council Congress, David J. Price, engineer of the Bureau of Chemistry, says that the Bureau has a record of 280 dust explosions in industrial plants, in 70 of which 459 persons were killed, and in 144 of which a property loss of $33,500,000 was incurred. Few of these seem to have been explosions of coal dust.

It is perhaps due to the intelligent study the results of which have been disseminated by the Bureau that the extensive development of the last decade in the use of pulverized coal has been effected with no serious and no considerable number of minor casualties of this kind. A mass of powdered coal could no more be exploded in its naturally compact condition than could a barrel of flour. A lighted match could be thrown with impunity into either. There is no such condition as there is in gunpowder, where the oxygen necessary for combustion is compounded with the other ingredients and needs only ignition to complete chemically the union.

But if either the flour or the coal is sprayed or atomized or shaken around so that it forms a cloud in the air, an open flame or even a spark may flash it, and it would impress something like two billion foot-pounds of energy upon the surroundings in the instant required for burning.

Freedom from leakage and scattering in transit and cleanliness in the premises where it is used, so that no accumulation may be suddenly joggled or blown from a beam or rafter, and the precaution never to put an open flame into an inclosed space where dust has been circulating, are the simple preventive measures recommended.

Ejector Exhaust for Steam Engines

LIFTING oneself by the boot straps is an idea the average man finds difficult to swallow, being regarded as having a tinge of necromancy. To many engineers the suggestion that the free, or atmospheric, exhaust of an engine be utilized to produce a vacuum within the cylinder possesses the same color of impossibility.

Those experienced in two-stroke-cycle gas engines often encounter instances when by accident, not by design, a partial vacuum in the exhaust pipe is produced by the gases rushing from the cylinder. If the engine has several cylinders with a common exhaust line, occasionally indicator diagrams reveal that this partial vacuum produced by the flow from one cylinder serves to decrease the pressure against which a second cylinder must exhaust. In some cases this action is sufficient to lower the cylinder pressure at the time compression starts, to as much as three pounds below atmospheric. In fact, more than one gas-engine designer has endeavored by experiment to obtain that definite length of exhaust line that would give these results.

Several years ago the idea was advanced that this phenomenon might be taken advantage of in uniflow steam engines, which resemble gas engines in their port exhaust. Considerable mathematics has been indulged in to prove the feasibility of the suggestion, and recently at least one manufacturer of uniflow engines has actually built such a unit.

Practical considerations point to the conclusion that the obtainable vacuum will not be considerable enough to make any marked diminution in the steam consumption at full-load rating. When lightly loaded, the engine will show but a minor vacuum, since the toe of the diagram representing the energy used to produce the induction effect is negligible.

It is on overloads, or long cutoffs, that the toe possesses a large amount of unexpended energy and the resulting vacuum should be considerable, but far less than that existing in a condensing engine. The great advantage that will obtain, if the eductor is commercially feasible, is the better overload steam consumption.

The efficiency curve of a uniflow engine is by no means flat, and at, say, twenty-five per cent overload the steam rate per horsepower is considerably above the full load of the economical rating. Since a two-pound rise on a high load means a total steam increase much above a corresponding rise at underloads, the desirability of flattening the efficiency curve at high loads is obvious. The eductor, by utilizing part of the energy still remaining in the steam when the exhaust ports are opened, will offset the drop in efficiency due to a late cutoff. As engines are generally rated at their most economical rating, apparently such an engine could be rated much higher than at present. This should in turn go far toward reducing the initial investment per horsepower.

If it be found possible to obtain a reduction in back pressure of four or five pounds, it is possible that the net plant economy would equal that of a condensing plant.

It is too early to conclude that the design problem has been solved, for rule-of-thumb methods are still necessary, but the plan has attractions.

Beware of Portable Electric Lights in Boilers

WHEN working around low-voltage circuits, such as used for lighting and small-power purposes, men are inclined to underestimate the hazard of such circuits under certain conditions. In dry places and with dry hands, one may touch a 110-volt circuit with the finger tips without getting sufficient shock to know if the circuit is alive. This is just where the danger begins, for immunity to an unpleasant shock under dry conditions is likely to lead to carelessness where it is wet and where a serious hazard to life may exist.

One of the most dangerous places where electric lamps are used, is inside a boiler. In these confined quarters the workman is usually perspiring, his clothes are wet and generally saturated with iron rust and other conducting materials, and his hands are in the same condition. A considerable area of his clothing is in intimate contact with the boiler, as may be part of his body. The boiler is thoroughly grounded through the piping to the water system and by other means. It would, therefore, be difficult to imagine conditions more favorable for obtaining an electric shock if a circuit is present. Another feature that adds to the danger is that if the workman comes in contact with an electric circuit in a boiler, he is generally in a position where it is difficult to get clear of the circuit and, if not shocked to death suddenly, is killed by a slow process from which he is unable to extricate himself.

The number of deaths caused by electric light currents inside of boilers shows the necessity of using every precaution to prevent coming in contact with a live circuit when working inside such equipment. What is true regarding working inside a boiler is true of working in any confined quarters where it would be difficult to get away in case of contact with a live circuit. Those who have studied these problems know that the greatest number of accidents to workmen occur with circuits of from 110 to 550 volts. Many of these accidents are primarily due to lack of proper precautions.

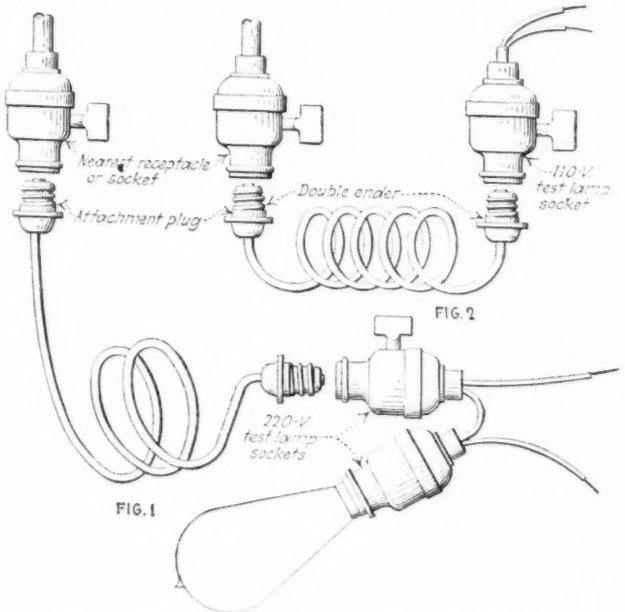
In working with an extension lamp in a boiler, there are three ways in which a shock may be obtained: By the strands of the conductors breaking and working out through the insulation, by defective insulation, and by coming in contact with the lamp's base or socket. If extension cord, heavily insulated with rubber, is used and the lamp socket is well insulated with rubber and friction tape, there is no danger. The solution to the problem is so simple that one wonders why so many fatal accidents have occurred. A portable lamp that may be safe to use outside of a boiler or in an unconfined place may be a serious hazard when used in such locations, therefore take no chances with such equipment and be sure that the insulation is up to high standards.

OUR GOOD FRIEND A. B. SEE, whose periodic observations on the social order of things has long served to arouse feminine ire, has again broken into print, in an open letter to Congressmen, with a protest against the proposed Cabinet office for Education. While Mr. See's protest is based largely upon the increased financial burden that would be incurred, it is apparent that he champions that group who see more benefit in the school of experience and hard knocks than in so-called higher education. There is undoubtedly much to both sides that cannot be ignored.

Practical Ideas From Practical Men

Handy Methods of Making Electrical Tests

Testing motors and lighting circuits, either alternating or direct current, is generally done with a lamp connected in series with a source of power, when a lamp test is sufficient. The connecting or disconnecting of lamp sockets, extension cords, etc., can be avoided to a large degree by the use of an extension cord with an attachment plug on each end. Many uses can be found for this simple device around practically every plant. The length of the cord between the plugs may be made to suit best the convenience of the individual case. Most maintenance men and electricians have two standard lamp sockets connected in series for use as a 220-volt



Figs. 1 and 2—Methods of obtaining test circuits from a lighting receptacle

test lamp and a single socket for testing on a 110-volt circuit. These, combined with the extension cord with an attachment plug on each end, provide a means of obtaining many convenient and time-saving connection combinations.

If it is desired to test the field coils of a motor and a test circuit is not readily available, one of the attachment plugs may be screwed into the nearest lamp socket and the other into one of two portable testing sockets connected in series. With a 200-watt lamp connected in the other socket, as shown in Fig. 1, a test circuit is available to test for open-circuits in the coils, grounds or the polarity of the coils. If shunt machines are being tested lamps of almost any size may be used, but for testing the polarity of small series motors, the large lamp is best suited. This arrangement also provides a handy means of testing resistance coils, magnet coils or circuit on controllers or other devices.

Another purpose for which the extension cord is handy, is to provide temporary power to a lighting circuit. If for any reason a circuit is dead and it is desired to make it alive temporarily, this may be done as shown in Fig. 2. The attachment plug on one end of the extension cord is screwed into the nearest live socket, and on the other end the attachment plug is screwed into a single socket that has been connected to two short wires. These wires are connected to the circuit that it is intended to make alive.

For use on an electric drill, bringing the light down to the work at the same time, one end of the extension cord may be screwed into the nearest lamp socket and the other end into one of the receptacles of a three-receptacle cluster, such as may be found around almost any plant. In one of the other receptacles is screwed a lamp and in the other the plug or the drill extension cord. This may be accomplished also by using an extension cord with an attachment plug on one end and a lamp socket on the other. In this case the lamp is removed from the nearest socket and the attachment plug screwed in. A double socket is screwed into the receptacle on the end of the cord, and this provides one socket for the lamp and one for the drill connection.

New York City. A. M. CRAWFORD.

Care of Automatic Sprinkler Systems

Although most engineers are familiar with automatic sprinkler systems of both the dry and wet type, we can always find new and easier methods of installing and maintaining these systems. With many years' experience with sprinkler equipment, I find the following advice would have been beneficial to me when I was new at the game.

Trip dry pipe valves at least once a year. I have found some corroded so much that it was almost impossible to pry the valve off the seat. Don't let a "dry" system fill with water unless unavoidable. Keep drum drips blown down and the entire system free from leaks. Have good electric alarm bells, preferably connected to a transformer from your switchboard. This does away with the failure and depreciation of batteries and is much cheaper in the end. Get acquainted with all the control valves and have a reliable man who knows how to shut them should a head be accidentally broken off. Keep guards on all heads in exposed places where they are likely to be damaged.

Whenever painting is being done, be sure to have the heads covered, as a little paint on the fuse link may make the head inoperative. When setting dry-pipe valves, be sure to clean the seat and the valve disk or both may be ruined. Use plenty of priming water and watch closely for an hour or two to detect any leaks in the valves. Should a leak occur in the "dry" system, I find soapy water applied with a paint brush the best method of locating the trouble. GUY W. KAY

Duluth, Minn.

Alcohol Keeps Plant Apparatus from Freezing

The winter before last was very severe here and the plant was forced to shut down for some forty days. We manufacture our own electrical power and naturally had to watch piping, pumps and other water-bearing apparatus rather closely in freezing weather.

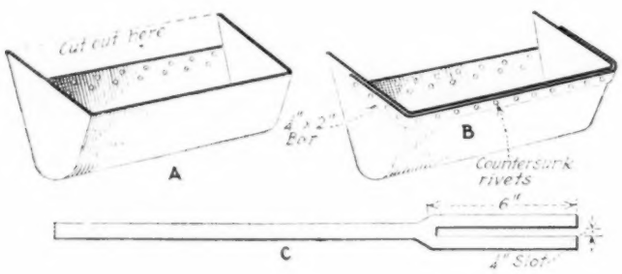
The winter was unusual, so we tried to keep ready to run any day and therefore did not open and drain everything. In order to be safe, I tried a plan that may be well known, but which I never personally ran across before. Taking a tip from my automobile, I poured a dose of alcohol into the steam-pump heads and in similar places where an accumulation of moisture might occur. Nothing froze, though I used very little alcohol. Examination at odd times showed that even when considerable moisture became entrained, it never froze to a solid block, but merely formed mush ice.

Oskaloosa, Mo. FRANK T. WARD.

Repair of Elevator Buckets

Having had considerable trouble with material getting jammed between the bucket and the belt in the continuous type of bucket elevator, the following method was used with success to overcome this trouble.

The sheet-metal bucket is usually provided with a back to come up to the next bucket, presumably to stop abrasion of a belt, by acting as a guard. The bolt holes are left with as much as four inches of clearance between the hole and the edge of the metal, making a place for the product to lodge and tending to hold the bucket away from the belt. This guard, or back, was cut off, leaving enough clearance, or landing, for the bolts, as shown in the illustration at *A*, and the bucket was bolted back on the belt. To find out whether the belt would suffer from the action of the material hitting it, this alteration was made on six buckets, and after



Alterations made to buckets

the elevator was run for three weeks it was examined for abrasion. None was found, but it was noted that at the bottom chute the material had a tendency to hit at the bottom of the bucket rather than high up. As a result the elevator was completely equipped with the cut-down bucket, and the maintenance costs due to buckets tearing the bolts out were eliminated.

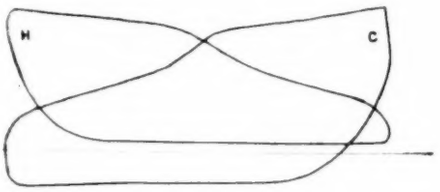
In handling some types of material, it is found that the outside edges of the buckets become ragged and bent back to such an extent that an appreciable amount of material is carried around over the top pulley and wasted. This wear may be overcome by removing the bucket, straightening the edge out, and riveting a piece of ¼x2-in. bar iron around the edge as at *B*.

When elevator bucket edges and sides become bent, a handy tool can be simply made from a piece of ½-in. plate cut as shown at *C*, and welded to a handle. By slipping the prongs over the bucket, the bent edge can be straightened. M. C. COCKSHOTT.

Monrovia, Calif.

Why the Non-Condensing End May Develop More Power When Engine Operates With Split Exhaust

A question asked from time to time by the Massachusetts examiner of candidates for first-and second-class engineer's licenses is this: "If a simple Corliss engine runs condensing on one end and exhausts at



Diagrams from engine operating condensing on one end and exhausting against 5 lb. pressure on the other

5 lb. back pressure for heating purposes from the other end of the cylinder, which end develops more power, assuming equal cutoffs?"

Many engineers say at once that the condensing end develops more power, as the vacuum is supposed to increase the power output about 25 per cent at the same cutoff through the increase in the mean effective pressure.

As the accompanying indicator diagram shows, the area of the crank-end diagram is greater than that of the head end, owing to the reduction in back pressure effected by the condenser. As the cutoffs and initial pressure are about equal on both ends off the cylinder, the only variable is the back pressure and apparently the m.e.p. is greater on the crank end. According to the accepted method of calculating power from diagrams, the crank end develops the greater power. But in my opinion there is a wide discrepancy between the apparent crank-end horsepower and the power actually developed during the piston stroke from the crank end to the head end and vice versa. The actual forward pressure on the piston when moving from the crank end to the head end is the pressure existing in the working end of the cylinder minus the back pressure of 5 lb. on the opposite side of the piston. The actual forward pressure when the piston is moving away from the head end is the pressure existing in the working end minus the back pressure of only 24 in. of vacuum on the other side of the piston.

As the forward thrust on the piston and, consequently, on the crank is greatest when the non-condensing end is taking steam, it would appear to disprove the common opinion that the condensing end develops the most power. As an illustration assume that the pressure up to the point of cutoff is 115 lb. absolute and the piston area 100 sq.in. Then the forward thrust is (115 — 3) × 100 = 11,200 lb. on the non-condensing end and only (115 — 20) × 100 = 9,500 lb. on the condensing end.

Springfield, Mass. A. F. SHEEHAN.

Comments from Readers

Checking the Number of Poles in an Induction Motor

In the Sept. 28 issue of *Power*, page 486, there was a short article on "How To Determine the Number of Poles in an Induction Motor." The article gave as one method of determining the number of poles the suggestion of checking the coil pitch. As the coil pitch used in winding the average induction motor is seldom full, or 100 per cent, this method would be misleading in many cases as can be seen from the accompanying table, because the coil pitch for different numbers of poles in a winding having the same number of slots overlap.

The coil throw is made less than 100 per cent to improve the magnetic field form and reduce the coil-end extensions and thus reduce the weight of copper.

The best method of determining the number of poles, if the nameplate data are not available, is to check the total number of pole-phase groups. This can be done a great deal easier than checking the coil throw, as the groups can be counted by removing one bearing bracket. The number of phases can generally be checked by the number of leads coming out of the motor frame, and the number of poles equals the number of pole-phase groups of coils divided by the number of phases. For example, in the 6-pole 48-coil three-phase winding there are 18 groups; 18 ÷ 3 = 6, the number of poles. One chance of going wrong on the number-of-groups method of checking the number of poles is on three-wire two-phase motors, but these are scarce and can be checked as the internal connections are changed over to four wires. There are also single-phase motors with four external leads as has the two-phase motor, and the multi-speed polyphase motors wound for two or more speeds that may have to be considered.

Wilkinsburg, Pa. A. C. ROE.

WINDING DATA ON FOUR-TO TEN-POLE INDUCTION MOTORS

No. Slots	No. Poles	Coil Pitch†																			No. Groups; Phases	
																					2	3
24	4	1–7*	1–6	1–5	1–4‡																8	12
24	6			1–5*	1–4	1–3‡															12	18
36	4	1–10*	1–9*	1–8	1–7	1–6‡															8	12
36	6				1–7*	1–6	1–5	1–4‡													12	18
48	4	1–13*	1–12	1–11	1–10	1–9	1–8	1–7‡													8	12
48	6					1–9*	1–8	1–7	1–6	1–5‡											12	18
54	4	1–14*	1–13	1–12	1–11	1–10	1–9	1–8‡													8	12
54	6					1–10*	1–9	1–8	1–7	1–6‡											12	18
72	4	1–19*	1–18	1–17	1–16	1–15	1–14	1–13	1–12	1–11	1–10‡										8	12
72	6							1–13*	1–12	1–11	1–10	1–9	1–8	1–7‡							12	18
72	8										1–10*	1–9	1–8	1–7	1–6‡						16	24
72	10												1–8*	1–7	1–6	1–5‡					20	30
96	4	1–25*	1–24	1–23	1–22	1–21	1–20	1–19	1–18	1–17	1–16	1–15	1–14	1–13‡							8	12
96	6									1–17*	1–16	1–15	1–14	1–13	1–12	1–11	1–10	1–9‡	1		12	18
96	8													1–13*	1–12	1–11	1–10	1–9	1–8	1–7‡	16	24
96	10															1–11*	1–10	1–9	1–8	1–7 1–6‡	20	30

†The numbers in the columns under "Coil Pitch," are the slot numbers representing the throw of the coil, that is, 1–19, means that if one side of the coil is in slot No. 1, the other side will be in slot No. 19, giving the coil a pitch of 18 slots.

*Full or nearly full pitch. In some cases the coils cannot be spread exactly full pitch on account of the relation between the number of coils and poles.

‡One-half or nearly one-half full pitch.

The smaller the number of poles and greater the number of coils in the machine, the more advantage is obtained from chording the coil pitch.

The table shows the coil arrangements possible when placed in the slots so as to have a pitch ranging from 100 per cent to 50 per cent for machines having 24, 36, 54, 72 and 96 slots and four to ten poles. These have been selected, as they represent some of the most active combinations.

In the machine with 24 slots and 24 coils, wound for 4 and 6 poles, the 4-pole line indicates that there are four possible coil throws, 1 and 7 being full pitch and 1 and 4 half pitch, which is as low as it is ever carried. The 6-pole line shows three possible throws. Both the 4- and 6-pole windings using 24 coils, have a coil throw of 1 and 5, or 1 and 4, or in checking a motor having 24 coils it could be taken for a 4- or 6-pole winding as a throw of 1 and 5 is full pitch for 6 poles and approximately 70 per cent pitch for 4 poles.

This overlapping of the coils' throw becomes greater as the number of coils in the winding increases, as seen in the 96-coil winding having 4, 6, 8 or 10 poles. The 6-pole winding overlaps, or has 5-coil throws common to the 4-pole winding.

Middle Age and Opportunity

The editorial in the Nov. 2 issue is appropriate at this time, for only last week I met an engineer who had been turned out by a new management that had come in. He was only 45 years old and had been in the job for more than 20 years. Last year I had a talk with him and tried to show him that conditions were changing, and pointed out that some day the old managers might die and that friendships did not enter into business.

The old manager did die, and the new one wanted to know "why and how." He called up the engineer and asked about certain new machinery and appliances for the plant. He wanted to know if they would not improve things. The engineer tried to conceal his ignorance behind a show of offended dignity and pride. He had often told me that books and magazines would never make an engineer or help run a plant, so he was completely in the dark and of course was told that they

would have to let him out. This will, I believe, answer the first question.

Does suspicion point to a man's ability when he seeks a job after reaching the age of 45? I cannot see that it does. If a man has been an engineer for a number of years, he certainly must have a record behind him that will dispel any suspicion as to his ability, and he can, if he is the right kind of man, show just why he is out of a job. If he has been on a job for 20 years and is thrown out, there is some good reason. True, in many instances it is hard for a man to adjust himself to a new line of work, but why? It seems that the older he grows the more he should be accustomed to the idea of taking the course of least resistance. If he has taken care of himself as he should have done in the past years, I see no reason why a man that has lived correctly should be mentally or physically unfit at 50 or even 65 years of age.

I have talked with many employers and managers, and as far as the power plant is concerned, they all prefer a man of mature years, one that has a long trail of experience behind him. Of course they do not want a cripple, but someone that can get around the plant, if necessary, without the use of a crutch.

I agree that engineers are poor salesmen, for if they were not, they would not be seeking jobs, but even a salesman must have quality in the article that he is trying to sell. This applies to personal qualities as well as any other line.

The writer has passed his milestone No. 52 on this rough old highway of life. Twenty-five years were passed afloat and in strange spots of the Globe. He has gathered no moss, but he has laid by a goodly store of experience, and would not be afraid to start out at any time to find another berth. With a record of the right kind as an anchor to windward, I do not think the old men need fear, if they can hit on at least three cylinders.

THOMAS M. STREET.

Wilkes-Barre, Pa.

The editorial in *Power*, Nov. 2, on "Middle Age and Opportunity," deals with a vital problem and one that many of us have had to face or will have to face sooner or later. It does no good to lament our fate or accuse others of treating us unjustly. Often, if we look at the matter fairly, we shall find that there are good reasons for the existing conditions and that most of our misfortunes can be traced to neglect on our part to prepare ourselves for the future. Let us consider some of the reasons why many firms will not engage middle-aged men.

In looking over the field we shall observe that this practice is not universal, and the exceptions are generally to be found with those firms that engage men for the duration of the job rather than for permanent positions.

Old and experienced field superintendents and skilled workers in the building trades can easily get employment provided that they are physically fit, and the same thing is to a certain extent true of inside engineering jobs which are understood to be temporary in their nature.

The fact is, there is more sentiment in business than some people are willing to admit. The hiring of men of 50 or 55 with the prospect that they may have to be laid off in 5 or 10 years without any pension or other means of support, is rather too much of a cold-blooded proposition for many employers to contemplate with satisfaction.

Many of the most promising positions must be filled by men who have been engaged with the prospect that they will grow up with the business, in which case the life expectancy of the men is an important factor. In the case of many large concerns that hold out to their employees the hope of permanent employment and steady advancement, it is impossible to engage old men to fill the better positions without detriment to the morale of the organization, and to engage such men for junior positions is not likely to prove satisfactory.

Having shown that there may be some good and valid reasons for the existing state of affairs, let us not waste time in lamentations, but let us see if we can adjust ourselves to the conditions with advantage. I think that it would be a great help to many if some of those who have found a way out of their difficulties would describe how it has been done.

As far as I am concerned, I can say that after working the greater part of my life as an employee, I find myself at an age exceeding that mentioned in your article, in practice for myself with prospects at least as good as any that I have previously had, and moreover, I look upon my somewhat fast graying hair as an asset rather than a liability. I am also agreeably surprised at the number of men of about my own age who are not hanging on to a payroll, but appear to be doing very well indeed.

There are opportunities for both young and old men who are qualified to take advantage of them. There may be fewer opportunities for the older men, but then there are fewer old men, and moreover, the older and more experienced men should be more capable of creating opportunities for themselves; but too often this is not the case, for in their younger days they did not realize the conditions that might confront them later on and prepare themselves accordingly.

On the other hand, it is never too late to mend, as many have found to their advantage, and I believe that a thorough discussion of this subject would open up many avenues and clear away unnecessary difficulties.

Newark, N. J. JAMES O. G. GIBBONS,
Consulting Engineer.

Engineering Failures

The discussion by Carl L. Wildey on the failure of engineers, which appeared in *Power*, Sept. 7, reflects the biased opinion of many practical men whose hard experiences and struggle for education combine to give them a self-satisfied air of responsibility in holding a "real he-man's job." Fortunately, the self-made men who are big enough to get anywhere realize that knowledge is knowledge regardless of its source and do not try to find imaginary differences.

It would indeed be interesting to know the name, school and additional details of the new graduate whose mythical answers are quoted. Such general statements smack so of gossip gleaned from the comic pages that they will not be taken seriously. Undoubtedly, there is a general feeling among college graduates that engineering examinations in general are simple. I had the same feeling many years ago when, after going to sea for a short while, I had ambitions to get a ticket. Although I never applied for a license, I made a study of the old questions and was somewhat surprised. Frankly, I doubt if I could have passed without some hard study.

Examinations are simple, but there are points of design and experience that are entirely outside the field of the average graduate.

As the average is determined by the majority, Mr. Wildey is rather sweeping in his statements. Certainly, college is no place to make an engineer, and most college men realize that after graduating, they are starting in the practical world just four years behind the high-school graduate who did not go to college and eight years behind the grammar-school graduate.

A comparatively small percentage of engineers choose to follow operating, but of those who do, no one can question their sincerity and determination to master the practical details of operations. No job is too dirty or disagreeable or hours too long if they are learning something. They will put up with work and conditions that the other men will not tolerate.

John Jones goes to college, makes many friends, has a good time, gets a start in life and a semblance of an education, all the time believing that he has a chance to be a second Hoover or Steinmetz, as his inclination may be. For ten or fifteen years after graduation he works hard, still believing that success is ahead. If by that time his dream does not materialize, he may become discouraged, but he still has the memory of pleasant years of life left behind.

During that period he has been in readiness and, if the opportunity had presented itself, could have grasped it. How many successful men are in their present position not because they put themselves there, but because they were on hand to take advantage of the opportunity?

With our advanced educational system, which I hope will never materialize, John Jones would walk over to a clinic, be examined and fitted out with a complete schedule of his future, of just what his education would consist of, where he would work, and what he would do the rest of his natural life. His only hope for excitement in life would be to get run over by an automobile and have his cut-and-dried life interrupted.

This educational efficiency would save a lot of embarrassment when refusing fireman jobs in case a chief's berth did not show up at once. No one would expect him to mingle with any but the class of men he associated with in college. At least the new efficiency would allow the segregation of those training for power-house operating positions so that they could be trained on a lower social scale with the result that after graduation their social obligations need not embarrass them.

This brings us directly to the question, Why do 60 per cent of the graduates fail? But do they fail? Looking at it merely from a monetary point of view, it is quite evident that a college education is a good investment. Statistics show that the average American family, not individual but family, earns $1,454.93 a year. Figures printed in *Power*, Aug. 31, give the average yearly earnings of 83 engineers as $3,724 ten years after graduation. This represents the replies of over 350 graduates of a single class of some 15 or 20 years ago. At that time a class of that size was considered large, and we may assume that practically 100 per cent of the graduates replied and are included, so that there is little opportunity of bringing in the old argument that the figures are not representative of the entire class.

At this rate the education pays the graduate $50 the first year, $250 the second, etc. If we assume the education to cost about $5,000, he could pay for it in a little over six years with his excess earnings. B. MARKER.

Los Angeles, Calif.

Changes Made to Boiler Setting Improve Operating Conditions

Referring to the article in the October 26 issue entitled "Changes Made in Boiler Setting To Improve Operating Conditions," certain adverse conditions in a boiler setting and furnace and the means adopted to overcome them are presented. The inference gained from reading this article might, in my opinion, be misleading.

The main trouble seems to have been that a stack temperature of over 1,200 deg. F. was obtained and that the furnace arches were burned out frequently. The existence of restricted gas passages somewhere in the setting, which would cause a "bottling" effect, might have been one cause for the arches burning out, but certainly had nothing to do with the excessive stack temperatures, and the enlarging of the areas of the gas passages between the furnace and the damper could have had but a slight effect on the temperatures at the damper. The raising of the arch over the stoker would tend to preserve the arch and give better combustion, but the reduction of area of the first pass, obtained by moving the front wall of the setting in, would have an effect opposite to that sought, as would the reduction of the throat between the furnace and the boiler setting proper.

There are not enough data given regarding rating of the boiler, net area of the original openings through the baffles between passes, the area of the stack breeching, and the condition of the baffles forming the different passes, to enable the forming of a correct opinion as to the true cause of the trouble.

It is not clear in what way three rows of tubes on each side of the boiler were "blanketed." If this means that six rows of tubes in each of the three tube banks in the boiler were covered so that the products of combustion did not come into direct contact with them, it would mean the loss of a substantial portion of the heating surface, and in that case, instead of the boiler being forced to 250 per cent of its rating, it would actually be forced to a considerably higher percentage of actual rating based upon the actual heating surface thus made available.

As previously stated, increasing the height of the arch in the furnace proper would help preserve the arch and tend for better combustion, and increasing the area of the openings through the baffles would improve draft conditions and therefore combustion and also tend to lower the temperatures between the constricted area and the furnace provided the original openings, as shown proved to be inadequate. Neither of these changes, however, could have any considerable effect toward reducing the excessive stack temperatures.

In all respects, with the possible exception of the two changes first mentioned, the original setting as shown in the Oct. 26 issue is far preferable to the redesigned setting also illustrated.

There would appear to be but two reasonable causes for stack temperatures as high as 1,200 deg. in any well designed boiler—an exceptionally dirty boiler or leaky baffles, probably in the lower portion of the first pass, which would short-circuit the products of combustion from the furnace throat directly into the third pass. If the latter was the cause of the trouble, it was probably remedied when the setting was rebuilt and the baffles reconstructed. J. D. CARR.

Los Angeles, Calif.

New and Improved Equipment

La Mont Steam Generator

The employment of small tubes, forced circulation, big reduction in weight and space required per unit of capacity, rapid steaming and high factor of safety are features of the steam generator brought out by the La Mont Corporation, 200 Fifth Avenue, New York.

The principle involved is that of injecting a small but over-sufficient amount of water into the top of a long ¾-in. tube in such a manner that the water forms a film on the interior of the tube. In passing down the tube, only part of the water is turned into steam, the remaining water, together with the steam formed, passing from the lower end of the tube into a manifold or header and thence to a separating drum, where the steam is liberated and discharged to the main steam header.

Referring to Figs. 1 and 2, the boiler consists essentially of a number of banks or trays of tubes *A* grouped together inside a vertical shell, a separating drum *B*, a circulating pump *C* and duplex strainer *D*.

The tubes comprising each bank or tray are expanded top and bottom into horizontal headers *E* which in turn connect with manifold *F* at the top and manifold *G* at the bottom, the general

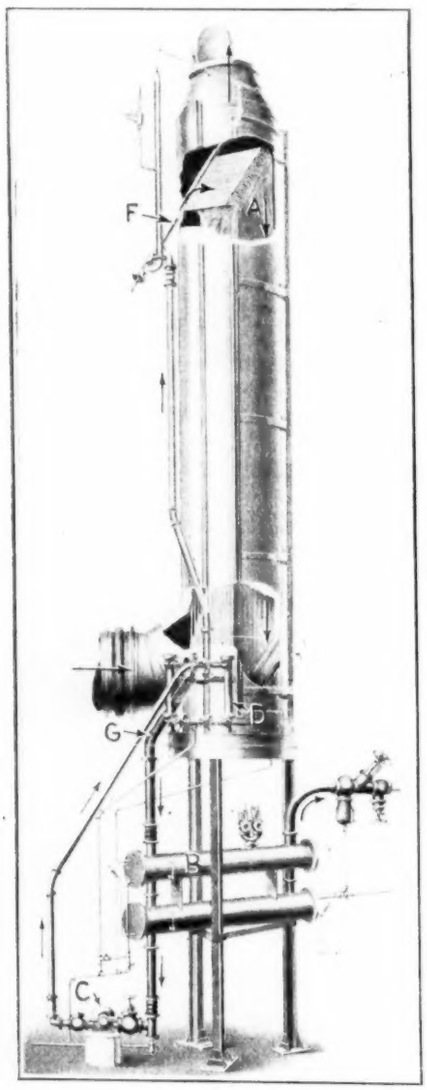


Fig. 1—Phantom view of boiler, showing closely space tube banks

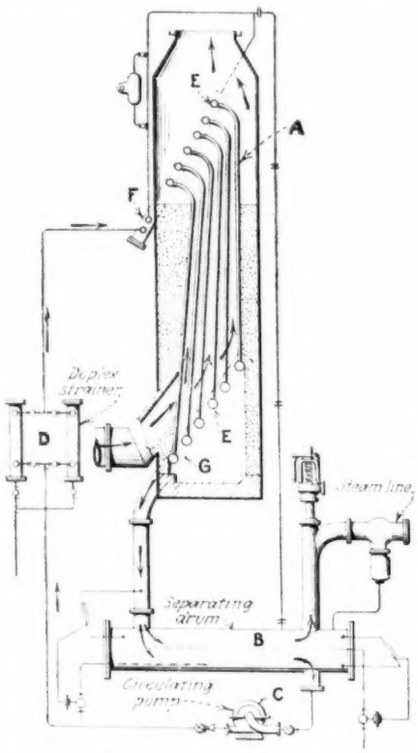


Fig. 2—Diagrammatic view, showing arrangement of component parts with interconnecting piping

arrangement being shown in Fig. 2. The tubes are spaced approximately ½ in. apart at the top and ⅝ in. at the bottom and are staggered relative to each other, this close spacing of small tubes being permitted by the film evaporation principle—and the straight upflow of the gases serves to give a high gas velocity and results in effective heat transfer with minimum draft loss. The relative space occupied by the tubes at the top and bottom of the generator and the arrangement of the banks in relation to the gas inlet are shown in Fig. 4. Dimension *X* represents the space occupied by the tubes at the top and dimension *Y* the space at the bottom.

A feature of the boiler is the method of injecting the water into the tubes. A small jet tube *H* is inserted in the header *E* (Fig. 3) into which the tubes are expanded, and the water is injected into each tube at the center through a small orifice. As the water strikes the sides of the tube, it tends to form

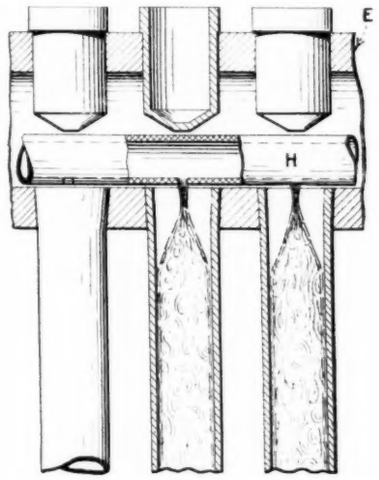


Fig. 3—Section of top header with jet tube in place

a film on the interior of the tube, owing to the adhesion of the water particles to the metal and the natural cohesion of the water itself. Thus it will be evident that, owing to the small size of the tube, violent ebullition will take place and, owing to the forced circulation assisted by gravity, the steam bubbles will be continually washed off the tube surface, resulting in high heat transfer and insuring a continuous wet surface.

It should be noted, however, that the unit is not in any sense a flash boiler, as the water is introduced at the coolest end of the tube, absorbing an increasing amount of heat as it flows downward and because from four to five times more water is injected into the tube than it is possible to evaporate with the given area.

Referring to Fig. 2, the flow of the water and also that of the gas are clearly indicated. As previously mentioned, the steam, which is generated in the tubes together with the unevaporated water, is discharged at the lower end of the tubes to a separating drum *B* where the steam is liberated. The unevaporated water, which is maintained at a reasonably high temperature owing to the constant circulation, mixes with the fresh feed water and a large portion of the carbonates and sulphates are precipitated in this drum and removed by blowing down. To prevent any impurities, other than those held in solution in the water, passing to the upper inlet header *E* and blocking the jets, a duplex

strainer *D* is inserted in the circulating system. This is blown down at intervals. It is claimed that, owing to the high temperatures of the water entering the tubes and the washing action of the descending film together with the precipitating action in the separating drum and strainer, the tubes are practically non-scaling.

The heating surface is incased in a round ¼-in. steel casing provided with a door opening sufficiently large to make the entire heating surface visible and removable. The shell is self-supporting from a ring base at the bottom, and this ring can be supported from three points at any height desired by three supporting columns or other suitable platform structure.

Although the first commercial generator was designed for waste-heat service and the initial installation which was made about a year ago is operating as a waste-heat unit on a water-gas generating set, it is readily adaptable for primary service.

Among the advantages claimed for this type of boiler is its adaptability to the high operating pressures now being adopted. Owing to the small size of the tubes and separating drum used, comparatively little change is necessary to make the boiler suitable for any pressures in use today, including pressures of 1,200 lb. The design has been carried out to meet accepted standards in such details as the expanding of tubes into headers, use of seamless drawn tubing for all parts subjected to heat and pressure as well as pipe and fittings.

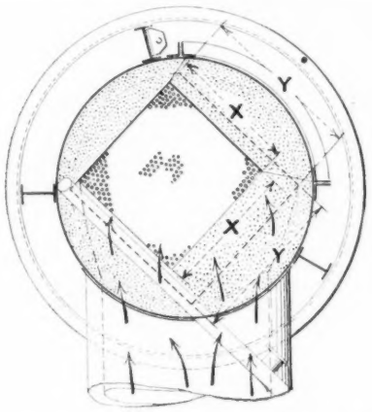


Fig. 4—Arrangement of tube banks in relation to gas inlet

In its present form it is also adaptable to provide greater power at high pressure in connection with existing lower-pressure boilers by connecting the gas inlet to one of the passes of the existing boiler.

Nicholson Flexible Coupling

The all-metal flexible coupling illustrated is being manufactured by W. H. Nicholson & Co., Wilkes-Barre, Pa. As shown by the illustrations, it consists of two cast-steel hubs keyed to the driving and driven shafts and provided with dovetail slots. Into these slots are placed floating steel keys. A cast-iron two-piece housing incloses the assembly and acts as an oil container.

When the driving shaft rotates, the centrifugal force throws the floating keys out into the slots. When the torsional load comes on, the angle of the slot is such that the centrifugal force of the floating keys is partly overcome

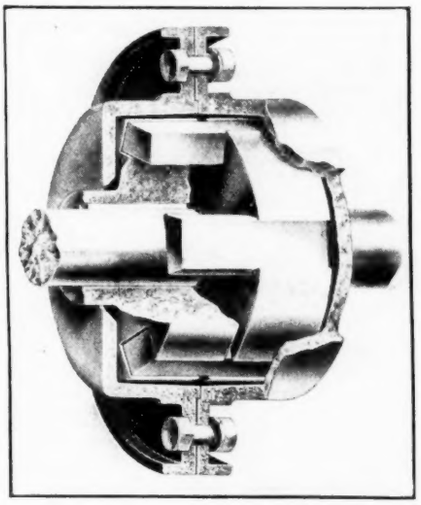


Fig. 1—Cut away view of coupling assembly

and they recede toward the bottom of the slots. Any wear that may occur in the sides of the keys after years of service, is taken care of by these forces. A film of oil is maintained between the keys and slots at all times, allowing a free lateral float of the coupling hubs. The hubs are machined all over and can be used in aligning the connected machines in the same manner as are flanged couplings. A gasket is used between the flanges to insure a tight

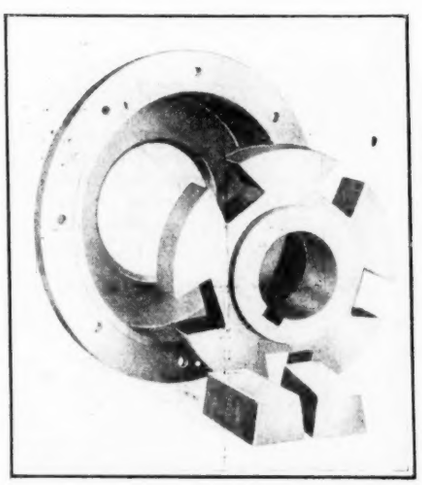


Fig. 2—Detail of coupling parts

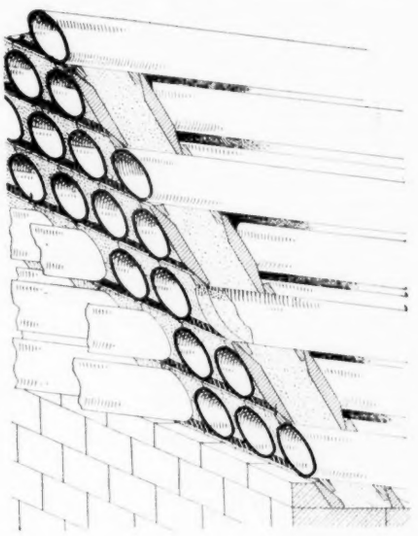
fit, making it impossible for oil to fly out. In case of an accident or wear and new keys are required, these can be readily supplied by any machine shop, but the combined strength of the keys is so much in excess of the shaft that there is little danger of breakage. The coupling is made for practically all sizes of shafts and all services.

"Super-Refracto" Boiler Baffle Wall

A baffle wall in the form of a tile-monolith unit, designed for easy removal and replacement of tubes, has been brought out by John A. MacDowell, president of the Boiler Baffle Wall Co., St. Louis, Mo.

The front and rear facings of the wall are of highly refractory tile plates, designed so that they join midway and completely encircle the tubes. Each horizontal row with its joints is overlapped at the bottom by the lower adjoining row in a shingle-like effect, the edges being beveled so that the plate centers are in line to form a plain, smooth wall surface.

With the front and rear plates in position the permanent wall is secured by pouring into the intermediate space an air-hardening liquid filler known as "Refractomant." The protection afforded by the refractory tile facing permits the use of the strong "Refractomant" bonding material, and as this "cures" into its permanent hardness, the several elements are gripped into a solid, monolithic wall.



Tile Monolith Baffle Wall

Features of the construction are the shaping of the holes in the plates to conform to the angle at which the baffle is inclined to the surrounding tubes and the provision for clearance space around the tubes. Originally, this space is filled with a special material, serving to make the baffle gas-tight and at the same time relieving the hard portion of the baffle from the usual dangers of punishment from turbining. The clearance space, formed automatically with the withdrawal of the old tube, allows easy insertion of the new tube. In the case of a badly warped tube a tile section may be removed, and with the new tube in place a new tile may be inserted.

The West Virginia Power Co. has applied to the Federal Power Commission for a license covering its project on New River just below Bluestone River. The proposal calls for an installation of 125,000 hp.

International Conference at Pittsburgh Marks Advances in Fuel Knowledge

A LEADING American engineer characterized the International Conference on Bituminous Coal as the best technical meeting held in the United States in a long time.

With a registered attendance of more than fifteen hundred, including the official delegates of 162 colleges, learned societies and governmental bodies in the United States and ten foreign countries, the meeting was a splendid tribute to the organizing ability of the officers of the Carnegie Institute of Technology, under whose auspices the conference was held. The four days, Nov. 15 to Nov. 18, inclusive, were occupied by morning, afternoon and evening sessions, several of them broken up into simultaneous discussions of special topics, and forty-three formal papers were presented. These, together with the discussion they stimulated, brought forth an almost overwhelming array of scientific and engineering material.

Enthusiasm was in every case the outstanding spirit of both audience and speaker, witness sessions in which dozens of men stood for two or three hours, the seats being fully occupied.

The subject-matter of the conference was principally the possibilities of coal carbonization with the production and utilization of byproducts, solid, liquid and gaseous; but serious attention was given to the attendant problems of waste-heat recovery, smoke prevention and power generation. The scope of the conference precludes a full report in the pages of *Power;* an effort has been made to select the features of greatest import to the power-plant engineer.

Foundation for Coal Research Proposed by President Baker

Opening the first session of the conference, Dr. T. S. Baker, president of the Carnegie Institute of Technology, emphasized the contributions pure-science research is making to the problem of economical fuel utilization. He felt that the highly unsatisfactory present condition of the coal industry would lead the operators to seek, as never before, the help of scientists and engineers in the solution of their problems. He proposed the establishment of a great American foundation for coal research in its most fundamental phases. Technical and scientific knowledge, he said, is as much capital as is money. A research staff can accomplish things that cannot be secured merely by credits. President Baker referred to the gathering in its international character as a messenger of peace and international co-operation.

U. S. Coal Reserves Total Thirty-four Hundred Billion Tons

Counting sub-bituminous coals and lignites and basing his estimates on the amount recoverable by intensive mining methods, R. Campbell, senior geologist of the United States Geological Survey, estimated the total remaining coal supply of the United States at the almost inconceivable figure of 3,419 billion tons. The amount recovered so far, he said, was 16.8 billion tons, which along with the mining waste represented a depletion of 25 billion tons. The total figures were admittedly little more than a scientific guess, but indicated that the United states holds approximately half of the entire world's coal resources. While this immense store removes any immediate anxiety regarding the coal supply, it did not relieve us, said Mr. Campbell, of the necessity of intelligent conservation, particularly in view of the fact that the high-grade coal is a small fraction of the total reserve. Dr. Campbell urged the importance of studying the utilization of the low-grade coals—sub-bituminous and lignite. Arranging coals by their geological age, he showed that the rank tended to increase from the Rocky Mountains toward the East. In Wyoming, he said, was America's thickest coal vein, one hundred feet deep. This bed, with its southern terminal at Casper, is the most important in the West.

ONE of the most interesting features of the International Conference on Bituminous Coal was the way it stuck to the business in hand. With no organization to maintain, there was no use for business sessions. No committees met. Everybody was free to devote himself to the prime object of the meeting.

Of course there was a lot of work behind a meeting so well conceived and organized, and the expense must have been great. All this, however, was taken care of by the Carnegie Institute of Technology, whose far-seeing officials grasped the significance of the present situation.

It would be better if the meetings of our technical societies could keep the machinery in the background to the same degree. Often it seems that most of the time and energy are devoted to discussing how best to polish the monkey wrench to do a job that could be done perfectly with a rusty wrench.

A danger that confronts every society is that its organization can so easily grow to the point where the major effort and a large share of the expense are absorbed by keeping the machine going with unbroken acceleration, or in correcting the unhappy results of injudicious direction.

Discussing the status of fuel research in Great Britain, Dr. C. H. Lander, director of fuel research of the Department of Scientific and Industrial Research, London, pointed out the fundamental distinction between the situation in that country and that in the United States. In England forty million tons of soft coal are burned annually in open grates. The result is an unparalleled smoke nuisance, which calls for drastic action. A smokeless fuel, produced by low-temperature carbonization, seems to be the answer. The same process should produce the motor spirit and fuel oil needed to insure the operation of ships and automobiles in a country that has no local supplies of petroleum. Dr. Lander outlined the relationship of the British research organizations and dwelt particularly on the experimental layout and carbonization experiments of his fuel-research laboratory. To make the low-temperature process pay, he said, would require much study, as the possible margin of profit is small.

Fieldner Says Fundamental Research Pays Best

A day when the smoke nuisance will cease and liquid and gaseous products made from coal will replace the waning supply of petroleum products was predicted by A. C. Fieldner, chief chemist of the United States Bureau of Mines, as the logical outcome of fundamental research now going on. His paper was presented in the Monday afternoon session, of which Samuel Insull was chairman. His paper was a plea for pure-science research as distinguished from so-called "practical" research. The latter, he said, often involved the waste of vast sums on ill-advised large-scale experiments where success could have been assured by preliminary work on the fundamentals. Coal should be dealt with in terms of its constituents, which should be the subject of exhaustive physical and chemical investigation. Until recently, said he, thorough scientific study of coal has appealed to but few workers. Now the situation is changed and hundreds of research workers all over the world are attacking the fuel problem from every angle. But lack of fundamental work in the past has left much ground to be covered before the scientific knowledge of fuels equals that in other fields. He contrasted the United States governmental appropriation of $127,000,000 to the Department of Agriculture with the two-million dollars allotted to the Bureau of Mines. Of the latter only a small fraction is available for fuel research.

German Plants to Liquefy Coal on Huge Scale

The process of coal liquefaction discovered by Dr. Bergius of Germany in 1913, has now been so perfected that from 40 to 70 per cent of the coal can

be transformed into oil by "hydrogenation" at high pressure, according to a statement made by the discoverer in his paper on the subject on Monday afternoon. One short ton of average bituminous coal, he said, will yield an average of 300 lb. of marketable gasoline, 400 lb. of middle fraction (including kerosene) 120 lb. of lubricating oil and 160 lb. of fuel oil. Except anthracite, nearly all grades of lignite and coal, especially screenings, can be liquefied.

The delegates from France. Left to right: Gabriel Bachaland, Henri Winkler, Gen. Georges Patart, P. Andrianne and Antoine Coing

Dr. Bergius said that some millions of dollars and twelve years of research work were necessary to make the liquefaction of coal an economical success. He told of two German plants, now under construction, with a total projected capacity of one million barrels of oil products per annum.

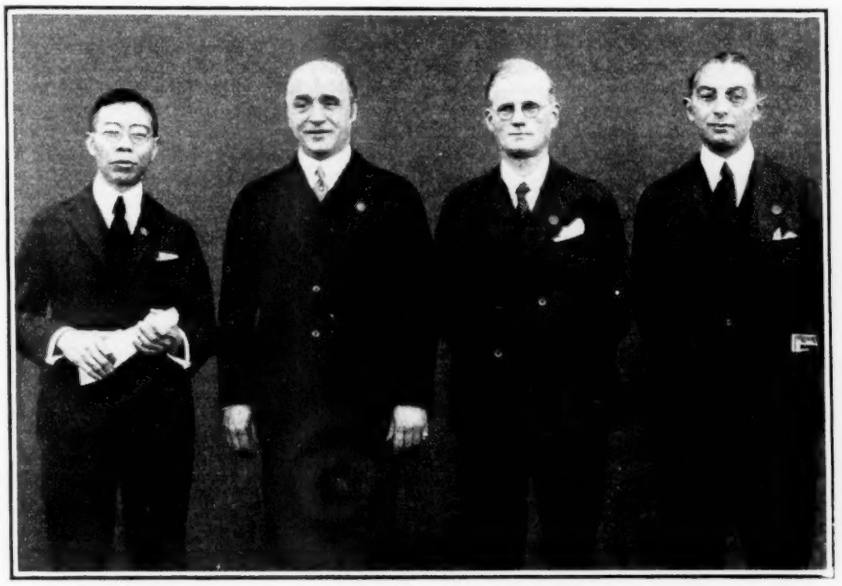
Dr. Bergius pointed out that the conversion of coal into oil is more particularly a European problem owing to the scarcity of natural oil in Europe.

The Bergius process is based on the fact that when coal is heated to 400-500 deg. C., the compounds of high molecular weight, of which the coal is composed, are split up into smaller groups, which are capable, without the use of a catalytic agent, of combining with hydrogen to form a complex mixture of liquid hydrocarbons essentially similar to mineral oil; also, in smaller quantities gas on the one hand and pitch-like products on the other.

In brief, the Bergius process is as follows: Coal is crushed (not pulverized) to medium fineness and mixed with some of the heavy oil, produced by the process, to form a thick paste. This is forced at 2,500 to 3,000 lb. pressure through a retort heated to 300-350 deg. C. Hydrogen is forced in at the same pressure. Some of this is absorbed by the coal. In a second retort, heated to 420 deg. C., most of the coal becomes a liquid by taking up more hydrogen. The unchanged coal is later removed and the liquid separated into motor fuel, Diesel oil, lubricating oil, pitch, etc.

Dr. Charles H. Herty, advisor to the Chemical Foundation, Inc., New York, made the statement after the meeting that four American manufacturers have already obtained licenses from the Foundation to operate under the Bergius patents. American title to these patents was obtained by the Foundation some years ago along with several thousand other German patents seized by the United States government during the War.

A session on Tuesday morning, under the chairmanship of John Hays Hammond, was devoted to chemical engineering phases of the fuel problem. General Georges Patart, of Paris, discussed the transformation of bituminous coals into organic technical products. Paul Dumanois, chief engineer of the French air service, gave a paper on methyl alcohol as a motor fuel. Coal and its mineral matter was the subject of a paper by Dr. R. Lessing, of London.



Three nations meet. Left to right: Yoshikiyo Oshima, of Japan; Friedrich Bergius, of Germany; Dr. C. H. Lander and Dr. R. Lessing, of England

Pulverized Fuel and Mine-mouth Plants Discussed at Power Session

Pulverized fuel and mine mouth-power plants were discussed by prominent engineers at the well-attended power session held on Tuesday afternoon and presided over by E. M. Herr, president of the Westinghouse Electric & Manufacturing Co. Walter E. Trent, the first speaker, described a new type of vibratory coal pulverizer designed for extremely fine pulverization and stated that anthracite pulverized to 300-mesh would burn as freely as 200-mesh bituminous coal. The cost of pulverizing, he said, is the determining factor in the comparison between these two fuels. He predicted that cheaper and finer grinding of bituminous coal would result in smaller furnaces and permit the successful use of low-volatile coals.

He said that pulverized coal can be made fluid for transportation in pipes without being mixed with air, by heating the powdered coal until the volatile products start to distill off, the vapors taking the place of the air commonly used to make pulverized coal fluid.

Mr. Trent described two processes of great interest. In one, powdered coal is carbonized by heating it very slowly while the gases pass back through the coal. In the other, pulverized coal is heated in suspension, evolving the volatile portion as gases which carry along the fine particles of coke, the whole constituting a sort of gasified coal that may be burned much like ordinary gas, although it is much richer. He suggested the use of coke dust, largely freed from ash by the amalgamation process, as a fuel for internal-combustion engines.

As a substitute for fuel oil under certain conditions Mr. Trent proposed the use of a liquid amalgam consisting

of 50 per cent of coal pulverized to pass a 350-mesh screen and 50 per cent fuel oil. This emulsion, he claimed, would remain fluid almost indefinitely and could be pumped and burned like ordinary fuel oil.

Recent Developments in Burning Pulverized Fuel

In his paper on recent developments in the burning of pulverized fuels, Henry Kreisinger pointed out a number of limitations of the refractory-lined furnace. Slagging of the ash erodes the walls, so direct impingement of the flame must be avoided. To protect the refractories, turbulence must be limited. This, in turn, keeps down the combustion rate and makes large furnaces necessary.

Water-cooled furnaces, according to Mr. Kreisinger, are not subject to these limitations, so that smaller furnaces may be used. He described the method of producing turbulence in which the coal and air are introduced in streams tangential to a circle in the center of the furnace.

It has frequently been stated that high temperature is one of the most important factors in obtaining high rates of combustion. Mr. Kreisinger felt that this was putting the cart before the horse. In his opinion the possibility of maintaining high rates of combustion rested almost entirely upon intensive mixing and turbulence, high temperature being the result rather than a cause.

He concluded his paper with a description, with lantern slides, of several recently completed boiler installations in which the furnace is more or less completely surrounded by water or steam cooled metal surfaces.

George A. Orrok Shows Limitations of Mine-Mouth Plants

In a paper on mine-mouth plants, George A. Orrok pointed out certain facts that have been largely overlooked by the popular exponents of the general use of such plants to do away with the transportation of coal. He said that water supply and nearness to market were the controlling factors. It requires from 500 to 1,000 tons of water to condense the steam produced by one ton of coal. Even if the water supply and the mine are side by side, a mine-mouth plant must have a market for electricity within reasonable transmitting distance.

He did not feel that cooling towers and spray ponds offered a solution of the water problem. Mr. Orrok said he knew of no station using cooling towers or spray ponds that had shown a heat consumption per kilowatt-hour of less than about 25,000 B.t.u. on a yearly basis.

Heat Storage and Automatic Control

In the last paper of the Power session F. P. Coffin, of the General Electric research laboratory, discussed the relation of thermal storage in boilers and furnaces to fuel application. The continual trend toward reduced heat storage capacity made the boiler sensitive to sudden changes in load and hence is an argument for the use of automatic combustion control. At the same time reduced heat-storage capacity put greater demands upon the automatic control.

F. R. Low Discusses Power-Session Papers

The discussion was opened by C. H. Berry, associate editor of *Power*, who read a written discussion by F. R. Low, who was unable to present it in person. It was pointed out that the power plant presents a splendid opportunity for the saving of coal through boiler-room improvement by methods already well understood, as evidenced by the success achieved in the better present-day plants. An increase from 60 to 75 per cent average boiler efficiency will save some 60 million tons of coal per year, with attendant savings in labor, cars, locomotives and handling facilities. The use of power, largely generated from the combustion of coal, has grown enormously during the last century, and the central-station industry has developed within a single generation to mammoth proportions. In the United States alone, during the year 1925, 61 billion kilowatt-hours were produced, and the world output was probably double that. All this is hastening the day when the struggle for heat sources will dominate the race.

Mr. Low said that recent developments in the use of high-pressure steam, with utilization of the exhaust heat, have enormously increased the possibilities in the dual use of steam, with the generation of power as a byproduct in the supply of steam for process heating.

The difficulty of the mine-mouth plant, so ably pointed out by Mr. Orrok, is perhaps more clearly understood when it is noted that a 300,000-kw. plant, which has been proposed, requires 300 to 400 million gallons of water a day, a supply sufficient for a city the size of Chicago. When the water supply is near the load center, the combined advantages of cheap vacuum and short transmission will usually justify the current practice in locating plants. The new station of the Columbia Power Co. at Cincinnati is said to have run a full month at a rate of 12,600 B.t.u. per kw.-hr., and many stations are putting current on the switchboard at an operating cost less than half a cent per kw.-hr.

No station, said Mr. Low, can, through location, combination of service or natural advantage, reduce this figure enough to satisfy the anticipations that have been aroused in the mind of the lay consumer as to possible reductions in his bills. Mr. Kreisinger's paper, he said, describes the latest developments in steam boilers, and the profession is watching with interest for reports of its performance under service conditions.

Mr. Hobbs, superintendent of power, Diamond Alkali Co., Painesville, Ohio, opened his discussion by referring to a remark of S. A. Taylor at the Monday morning meeting, to the effect that the discharge of pulverized-coal ash from power plants has increased the business of laundries. Admitting that some ash is discharged, he stated that his investigations have failed to disclose any instance of measurable damage, even in thickly populated regions.

With reference to Mr. Trent's paper, he inquired how it was proposed to maintain the temperature of the hot coal and coke flowing through the apparatus, and further said that he felt that the handling of hot pulverized coal and distillation products is fraught with danger of combustion or explosion. Mr. Hobbs also questioned Mr. Kreisinger's statement that flame impingement on water-cooled wall structures is permissible. He felt that protection by refractory coverings is sometimes needed.

Mr. Pettibone inquired concerning the minimum rate of heat liberation per unit of volume that has proved consistent with good combustion.

In reply to the discussion, Mr. Trent said that moving hot coal is much like moving hot steam. The piping must be adequately insulated to avoid heat loss. Also, he said, the danger of combustion in transit is no greater than for the handling of present forms of liquid and gaseous fuels.

Mr. Kreisinger said that combustion rates down to 10,000 B.t.u. per cu.ft. of total furnace volume have been attained without trouble of any sort. Since the active combustion zone is really about half the total volume, the actual rate is probably nearer 20,000 B.t.u. per cu.ft. of active combustion volume. A range of working from 1 to 4 should be sufficient for all practical needs.

Mr. Kreisinger further remarked that it seems unwise to install water-cooled wall surface and then cover it up with refractories so that it cannot absorb heat. Boiler tubes, absorbing heat at much higher rates than wall surface, require no protection. "Why do the wall tubes need it?" he asked.

Hammond, Barnum and Slosson Interpret Conference to Public

As a means of helping the general public, as well as the delegates, to sense the significance of the Coal Conference in a broad way, a special meeting was held Tuesday night. Largely attended, and addressed in a masterly manner by three well-known speakers, this meeting was a distinct success.

The chairman, John Hays Hammond, predicted present or future benefits to four industries from coal studies now under way. To the coal industry will be opened new markets for fuel. The gas industry will learn to make gas more economically and to attain a far larger recovery of byproducts. In the future, central stations strategically located may produce great quantities of motor spirit and other oils as a by-product of power generation. With dwindling petroleum resources, the oil industry may find in the distillation and distribution of carbonization products a use for their heavy investment in equipment for refining and distributing petroleum products.

Like many other speakers and writers during the last year, Mr. Hammond stressed the importance of research in pure science and said our national expenditure for this purpose ought to be doubled or tripled.

The dependence of modern industry

on a constant supply of bituminous coal was pointed out by Walter Barnum, a Seattle mine owner, who heads the National Coal Association. Coal is and must continue to be the chief source of power, and improvements in technique increasing the energy-producing capacity of coal are of immense significance. Removal of petroleum in the near future from use as industrial fuel was predicted.

The speaker dwelt on the manner in which the bituminous industry had met its responsibility with respect to the demands of transportation and manufacture.

Irregularity of operation, he said, is due to irregularity of demand. If this irregularity is to be abolished or reduced by legislative fiat, he declared, the regulation must be applied to coal consumers and not to coal producers.

Discussing the social interest in the utilization of labor-saving devices because of the lessened cost of production and the consequent reduced selling price of the product, Mr. Barnum extolled the record of American industry. In 1924 the comparative figures for coal cut by machine were for the United States 70 per cent and for Great Britain less than 19 per cent. "Our output of coal per man," he said, "stands out in striking contrast to that of other countries. Thus in 1924 the average yearly output per man was: in Belgium, 152 net tons; in France, 167 tons; in Germany, 234 tons; in Great Britain, 246 tons; and in the United States, 734 tons, or almost exactly three times that in Great Britain, our nearest rival. It is high rate of productivity, due largely to the efficient equipment and management of our mines, that has made it possible to furnish this essential fuel at the lowest mine prices in the world."

Edwin E. Slosson, Director of Science Service, Washington, D. C., spoke on "The Coming of the New Coal Age." In the old coal age, which has lasted some 600 years, he said, we knew nothing better to do with coal than to burn it. In the new coal age now opening, we are learning better uses. We are beginning to realize the value of coal as a source of raw material for the synthetic chemist.

In 1913 nearly three-fourths of our coke was made in beehive ovens that wasted the tar, ammonia and light oils. In 1925 more than three-fourths of our coke was made in ovens recovering these byproducts. Last year was the peak of American coal-tar production, over 528 million gallons, but 60 per cent of this was used as fuel instead of being worked up into chemical compounds.

The mobility of man and his growing energy come from the earth's stores of fossil fuel intelligently applied. The expansion of Europe is based on the expansion of gases. The mobility of man is measured by the mobility of his power, hence the efforts to increase the fluidity of fossil fuel, to make oil from coal.

The chemical aspects of coal carbonization and byproducts recovery, the utilization of coal-tar products, and other important problems in coke and gas works practice were the subjects of four sessions on Tuesday and Wednesday.

Fuel Economy in the Iron and Steel Industry

Discussing fuel economy in the iron and steel industry, H. A. Brassert, consulting engineer, said that this industry consumes 20 per cent of the country's bituminous-coal production. Most of this is completely gasified either in gas producers or coke ovens by high-temperature distillation and subsequent burning of the coke in blast furnaces or cupolas; a relatively small amount is fired under boilers or otherwise. Improvements in fuel utilization, he thought, would eliminate the smoke and dust nuisance now generally associated with steel-plant operation.

From the viewpoint of ultimate economy, said Mr. Brassert, blast-furnace and coke-oven gas should be applied first to all uses where a solid fuel cannot be utilized and only the remainder supplied to boilers and similar uses where solid fuel can be burned with almost equal efficiency and convenience. To gain the proper perspective in the matter, the industry should be regarded not only as a producer of iron and steel, but as one of gas and power, for distribution to affiliated and neighboring industries, public-utility companies and communities.

What Is "Smokeless" Fuel?

The problems of smokeless fuel and smoke prevention were discussed in one of the Wednesday afternoon sessions. O. P. Hood, of the Bureau of Mines, pointed out that the problem of defining smokeless fuel was not so simple as it might appear to the layman. In fact, smokelessness is largely a matter of degree and involves the question of how the coal is burned. Combustion engineers can burn high-volatile fuels with practically no smoke. If "smokeless" means that no smoke will be produced even in inexperienced hands, it may be applied to anthracite, coke and briquetted fuels in which the volatile content of the binder is removed by a final heating. Semi-bituminous coals, while not strictly smokeless, go a long way to mitigate the smoke nuisance in cities. Mr. Hood suggested that a partial solution of the problem might lie in the future use of low-priced gas for house heating.

Porter and Monnett Say Education Alone Cannot Solve the Smoke Nuisance

Education can mitigate, but not solve the smoke nuisance according to a statement made by H. C. Porter, consulting chemical engineer. Large power plants, under public pressure, have learned to burn bituminous coal with little smoke, but locomotives, small power and heating plants and domestic furnaces still offend and will continue to do so, in Mr. Porter's opinion, until they can obtain a relatively smokeless fuel at a cost but little higher than raw bituminous material.

Like Mr. Porter, Osborne Monnett, consulting engineer of Chicago, was decidedly pessimistic regarding the possibility of eradicating the smoke nuisance by any campaign of education. In the absence of Mr. Monnett, the paper was read by Professor Wohlenburg, of Yale University. It will take a generation, according to Mr. Monnett, to get the average householder to use properly designed furnaces and handle his fires with intelligence.

The discussion was started by R. T. Haslam, professor of chemical engineering at the Massachusetts Institute of Technology. He said there was little smoke problem in the industrial field except in connection with return-tubular boilers, hand-fired and with low settings. Such installations, he said, were rapidly passing away. Professor Haslam said that high density was an important characteristic of a commercial briquet for low cost of shipping and other reasons. Cleanness is another. He felt that the gas industry should look upon smokeless fuel as the main product and gas as a byproduct.

Processes of Low-Temperature Distillation Described

The Thursday sessions were devoted to papers on nearly a dozen different processes of low-temperature carbonization, indicating the extent of the experimental work now going on in this field. The following abstracts will be limited to a few processes of special interest to power engineers.

Carbonization of Mid-Continental Bituminous Coals

A paper on the low-temperature carbonization of bituminous coals of the mid-continental type was presented by S. W. Parr, professor of applied chemistry, University of Illinois. After remarking the changing point of view with respect to coal analysis, he described the carbonization method devised at the University of Illinois, which produces good coke for domestic use.

Report on Low-Temperature Plant at Fairmont

C. V. McIntire presented a paper on the low-temperature distillation plant now in semi-commercial operation at Fairmont, W. Va., which yields briquets and low-temperature byproducts. To date, 22,000 tons of coal have been carbonized.

The McEwen-Runge process, now said to be in commercial operation at the Lakeside Station of the Milwaukee Electric Railway & Light Co., was described by Dr. Walter Runge, of the International Combustion Engineering Corporation. The present plant, representing the knowledge gained in a long period of experimentation, is housed in a building 140 ft. high, 40 ft. long and 25 ft. wide, with a smaller building for exhauster and pumps.

The rated capacity of the Milwaukee unit is 210 tons per day, and prolonged runs have been made at the rate of nine tons per hour. The estimated possible capacity is considerably higher. At present the plant is operated with 16 men per 24 hours—five men per shift and one foreman. It is quite probable that this can be reduced to thirteen men or even less.

News in the Field of Power

Large Exhibition and Live Meetings Star Features of Welding Convention

Meeting at Buffalo Holds Demonstration of New Hydrogen-Arc Process—Railroad and Structural Steel Welding—Atomic Welding Torch—Reports on Welding Instruction

AN INTERNATIONAL exhibition of welding equipment and applications, a discussion of the place of welding in the engineering curriculum of universities, and sessions devoted to advances in the fabrication of structural steel by welding and welding practices on the railroads were features of the fall meeting of the American Welding Society held in Buffalo, Nov. 16 to 19, inclusive.

The new hydrogen-arc process of welding, described in the March 23 issue of *Power*, was demonstrated. Other activities included an inspection trip to Niagara Falls with a visit to the power plant of the Niagara Falls Power Co., and a dinner dance at the Hotel Statler. The technical sessions were held in rooms adjoining the huge Broadway auditorium which housed the International Welding Exposition.

At the opening technical session on Wednesday morning, M. Gjersten, master welder of the Northern Pacific Co. presented a paper on the welding of locomotive parts, a process which is extensively used in locomotive repair work. "While wonderful progress has been made by the railroads in the last few years in the application of the fusion-welding process," said Mr. Gjersten, "much still remains to be done before the full value and economy of each individual process can be realized."

Railroad Use Growing

A much more extensive paper by F. H. Williams, assistant test engineer of the Canadian National Railways, dealt with the organization of welding on the railways and showed the great dependence now placed on welding by the railroads for every variety of repair work. He listed in detail the methods of performing various routine repairs, the equipment and material required and the savings effected. Some of these data, as for example those relating to the repair of locomotive pistons, should be of value to the engineers of stationary plants faced with similar problems.

While this railroad permits no welding of any kind to be done on boiler barrels or on unstayed pressure vessels, welding is extensively used in the repair of fireboxes and other stayed surfaces. The cutting torch is used extensively for removing staybolts, rivets, etc.

While few of the readers of *Power* are professionally concerned with the fabrication of structural steel, it is worth noting as a matter of general engineering information that a marked increase in interest in this matter was shown at the convention. Representatives of the steel fabricators as well as manufacturers of welding equipment took an active part in the discussion of the papers presented on this subject Wednesday afternoon and had the opportunity to inspect completely welded roof trusses, test specimens and similar exhibits in the main exhibition hall.

A paper by H. H. Moss described tests made by the Linde Air Products Co. on oxyacetylene-welded roof trusses. The results obtained showed increased strength and rigidity as compared with riveted construction, as well as a material saving in the total weight of steel required. The tests were made in the presence of distinguished experts.

Tests on Structural-Steel

A. M. Candy, of the Westinghouse Electric & Manufacturing Co. gave the results of a large number of tests made on structural-steel joints fundamentally designed for arc-welded connections. These were conducted at the Carnegie Institute of Technology. One of the advantages claimed for welding in this connection was the possibility of producing a continuous beam effect with greater strength for a given beam section.

One of the points emphasized by the papers and discussion at this session was the importance of designing welded structures and equipment for welding, rather than trying merely to replace rivets by welding. The two methods of fastening were fundamentally different and had to be treated as such in all stages of the design. One of the purposes of the work reported by Mr. Candy was the development of suitable detail standards for structural designers.

The demonstration of the atomic welding torch was made by R. A. Weinman, of the General Electric Co., who also described briefly the theory of its operation. As previously explained in *Power*, this torch directs a stream of hydrogen between the poles of an electric arc where the molecules of hydrogen are split into individual atoms. Issuing from the arc, these atoms shortly recombine into molecules with the generation of intense heat with which the welding is performed. Streams of hydrogen bathe the weld and the adjacent heated portions of the work, preventing oxidation.

As an entirely new departure in welding conventions a session was devoted to a group of papers on the place of welding in the engineering curricula of universities. Among those presenting papers on the subject were Prof. S. T. Hart, of Syracuse University; O. D. Rickly, of Ohio State University; W. P. Turner of Purdue; Ernest L. Lucas of the Mississippi Agricultural and Mechanical College.

A questionnaire sent to a large number of technical schools by Professor Hart showed that a considerable number were giving some place to welding in their courses, mainly in the shop work. Of sixty answers received, thirty reported the use of electric welding apparatus, 60 per cent of gas apparatus and 10 per cent the use of Thermit apparatus.

Welding in Universities

Forty seven per cent of the universities replying had the students make use of welding apparatus, 50 per cent gave lectures on the subject, and 81 per cent explained welding to the students. It was pointed out by Professor Hart that universities could not possibly attempt, in the limited time available, to make their students proficient in the whole gamut of mechanical subjects.

The paper of O. D. Rickly said that little had been done so far in teaching the theoretical aspects of the problem.

It has been proposed by leaders of the welding industry, and also editorially in *Power*, that design for welding should be incorporated in the design courses along with the design of riveted joints, so that students would be prepared to give them equal consideration after graduation. These proposals were made recently and it was evident that very little has as yet been attempted along this line.

Forty Exhibitors Display

The technical sessions were well attended. Welding exhibits were more extensive than the Boston meeting last year, over forty exhibitors showing great variety of welding machines and equipment. Of special interest to *Power* readers were exhibits of welded pipe and fittings, bronze welded repair cast iron gears and eroded water wheel, also the welded pressure vessels and fabricated ammonia coolers. There were in all nearly fifty exhibits, mostly large and well staged. The university session discussion was participated in by Prof. Comfort Adams of Harvard, Philip Swain, **Power** editorial staff, and others.

The general agreement was that colleges should not train welding specialists, but teach welding design fundamentals, and familiarity with apparatus.

Professor Adams predicted enormous growth in welding applications. Thursday afternoon session the welding wire specifications committee analyzed results of extensive investigation regarding what makes wire suitable or unsuitable, which was followed by an important meeting of the American Bureau of Welding, of the research department of the Society. Subjects proposed as research projects are as follows: Fundamentals of welding, testing welds without destruction and pressure vessel investigation co-operating with the boiler code committee.

License Requires Governor's Approval—Says New Law

The new "State Departments Law," which goes into effect January 1, 1927, provides under section 249 that:

"Notwithstanding the provisions of article 10-a of the conservation law, a license under the provisions of such article issued by the water power and control commission shall not be effective unless and until it is approved in writing by the Governor and such approval is signed by him and affixed thereto. A modification of such license shall not be effective until approved by the governor in like manner."

This provision was written into the State Departments Law, which statute reorganizes the state government, in accordance with the recommendations of the Hughes Commission. The question has arisen at Albany, N. Y., as to what kind of a function the Hughes Commission intended to confer upon the Governor, whether a mandatory or permissive exercise of power.

Vital to St. Lawrence Project

Especially is this question pertinent with the applications now pending before the present water power commission for St. Lawrence River power development and the water power commission is apparently marking time awaiting the call of the chairman of the present commission, Conservation Commissioner Alexander MacDonald before taking final action in the matter. Governor Smith has requested the Commission to defer final action on such applications until after January 1, when the new state departments law will go into effect.

If the power conferred upon the executive is purely administrative, the question naturally arises: "Is such grant of power to the executive constitutional?" At the present time the power of the Governor is limited to recommendations to the legislature, the vetoing of bills, appointments and removals of certain officials, the commutation of sentences of prisoners, the inauguration of investigations under the public officers law and the Moreland law, and certain other miscellaneous functions. His O. K. is not required upon the usual administrative acts of various governmental activities.

If the function conferred upon the Governor is purely administrative, is not the exercise thereof in accordance with the findings of the water power and control commission mandatory? That is, if the licensing body proceeds in accordance with the provisions of article 10-a of the conservation law and gets to the final stage where it is ready to issue a license for power development, can the Governor, with such law still existing as a part of the statutes of New York State, because he is of the opinion there should be a different law providing for development by a state agency, refuse to ratify the action taken by the licensing body?

In the reorganization plan the executive law has not been amended so as to confer upon the Governor the right to veto a recommendation of the water power and control commission, nor has there been any attempt made to reconcile by additional law the apparent attempt to confer a new function upon an executive official.

New York Power Leases Off—Reorganization Plan Soon

That there will be no action by the New York State Water Power Commission authorizing private leases for the development of the state-owned hydro-electric power sites on the St. Lawrence River, was the opinion expressed at Albany, N. Y., Nov. 17, after four of the five members of the commission had an informal conference.

Although all the members of the commission, except its chairman, Conservation Commissioner Alexander MacDonald, were in Albany to attend meetings of other boards and commissions, no meeting of the Water Power Commission was held. Furthermore, it is understood, there is little likelihood of there being another formal meeting before the end of the year when, under the state reorganization program, the Water Power Commission goes out of existence as a separate entity.

N.E.L.A. Convention Slated for Atlantic City

The fiftieth convention of the National Electric Light Association will be held on the Million Dollar Pier, Atlantic City, N. J., June 6-10, 1927. In conjunction with it, an exhibit for the products of manufacturers will be held from June 4 to 10.

The choice of Atlantic City as the next convention city was announced by President R. F. Pack at the recent meeting of the national executive committee in Chicago, and was unanimously ratified by that committee.

At a meeting of the exhibition committee of the N.E.L.A. in New York, Friday, Oct. 22, preliminary plans were based upon the assumption that the next exhibit will surpass even the record-breaking one of 1926, which also was held on the Million Dollar Pier in Atlantic City.

New Lamp Has No Physical Connection With Circuit

At the recent regional meeting of the American Institute of Electrical Engineers, held in New York City, Ted E. Foulke, research engineer of the Cooper Hewitt Co., described a new type of electric lamp. This lamp is known as the induction type, as it has no physical connections to the circuit on which it operates.

The lamp consists of a glass bulb, not unlike that used in some of the larger size conventional type lamps, except in the induction type where there are no metal parts. In this bulb is placed a drop of mercury about the size of a pea, after which it is exhausted to a very high vacuum and then is filled with a rare gas such as argon or neon at a very low vapor pressure.

High-Frequency Used

To operate the lamp is required an equipment for producing a high-frequency current at a comparatively low voltage. This current passes through a helical coil having seven or eight turns, in which the lamp is inserted. The theory of the lamp's operation is that the negative electrons of the gas in the bulb, when excited by the high-frequency field of the coil, are caused, temporarily, to increase the radius of the orbit in which they rotate. As these electrons give up their energy by coming in contact with other electrons, they move back to their original orbit. It is this moving back and forth of the electrons between different orbits that produces the light radiation.

Value of Rare Gas

One of the purposes of the rare gas in the bulb is for starting the lamp in operation, as it provides a means of automatically vaporizing the mercury in the bulb. If it were not for the presence of the rare gas, it would be necessary to heat the bulb to get the light started. Lamps of this type have been made that give 18 candlepower per watt. When compared with the old 16-candlepower carbon-filament lamp that required 50 watts, this new lamp gives 56 times as much light for the same amount of energy. Instead of using mercury in the lamp, other metallic substances may be employed, depending upon the quality of the light desired.

Many Applications Expected

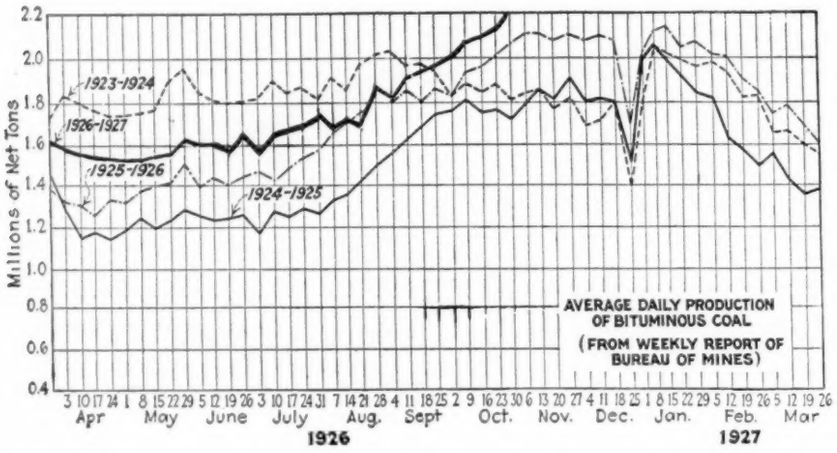
Experiments have been made at different frequencies ranging from 50,000 to 2,000,000 cycles per second. The electrical conditions seem to vary considerably over this range. For instance, with 50,000 cycles the current circulating in the helix was about 300 amperes before the discharge occurred, whereas at 2,000,000 cycles the circulating current was only a few tenths of an ampere.

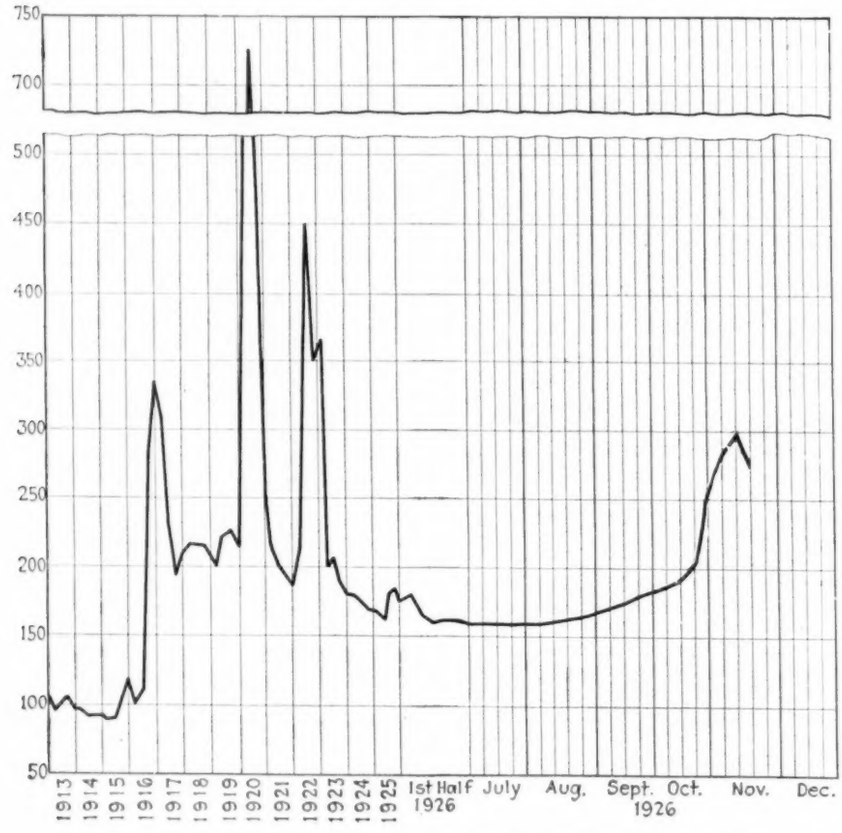
It is too early in the development of this lamp to predict its utility, but Mr. Foulke expressed the opinion that many applications will be found, for its richness of visible, near ultra-violet and far ultra-violet rays will adapt it to special uses where the initial cost of the auxiliary equipment will not be of prime importance. In the visible region efficient lumination can be obtained, while the near ultra-violet region can be used in photography and in fluorescent stage effects. The far ultra-violet region will find its usefulness in therapeutics, sterilization, dye-fading, leather processing, promoting photochemical action and in a wide field of research.

Larger Coal Stocks Indicate Need for Lighter Buying—Overselling Feared

BITUMINOUS coal is having a remarkable revival due to the anxiety of American purchasers to provide coal against a strike that is to be anticipated beginning April 1, 1927, and to the demand for coal in Continental Europe and in Great Britain, which in turn results from the strike in Great Britain.

The report of the United States Bureau of Mines on consumers' stocks shows that between May 1 and Oct. 1 stocks rose from 36 to 44 million tons and doubtless they are higher now than then. The highest figure for stocks ever ascertained was 62, January, 1926. The companies reporting include every steel plant, every byproduct coke plant, every railroad of size (these figures are furnished by the American Railroad Association), nearly every coal-gas works and 595 of the largest electric utilities. Besides, the list includes more than 2,000 general industrial plants and 877 of the larger retail dealers.





Coal Age Index of Spot Prices of Bituminous Coal F.O.B. Mines

	1926				1925	1924
	Nov. 15	Nov. 8	Nov. 1	Oct. 25	Nov. 16	Nov. 17
Index	275	299	285	249	190	170
Weighted average price	$3.32	$3.61	$3.45	$3.02	$2.30	$2.06

This diagram shows the relative, not the actual, price on fourteen coals, representative of nearly 90 per cent of the bituminous output of the United States, weighted first with respect to the proportions each of slack, prepared and run-of-mine normally shipped, and second, with respect to the tonnage of each normally produced. The average thus obtained was compared with the average for the twelve months ended June, 1914, as 100, after the manner adopted in the report on "Prices of Coal and Coke: 1913-1918," published by the Geological Survey and the War Industries Board.

The total stocks shown by these signed reports were 28,000,000 tons, or 64 per cent of the estimated total. Although the estimated total allows for some 88,000 plants not reported, these plants are assigned only 35 per cent of the estimated total.

While the total reached in the stock report is an estimate, it nevertheless rests on substantial knowledge, it is pointed out by bureau officials.

The average spot price f.o.b. mines of fourteen coals representative of nearly 90 per cent of the bituminous output of the United States was in June only $1.89, on Oct. 18, $2.45, and on Nov. 8, $3.61. There is urgent need to keep prices from further soaring, and this can be done by advising consumers not to buy heavily at present prices. At the rate of production now being attained, it is likely that before April 1 the coal industry will be heavily oversold.

It is needless to say that the coal mines are opening, and wages are being increased, which accounts for some of the increased costs of production.

Society Affairs

The Boston Section of the A.I.E.E. will be addressed by Dean Dexter S. Kimball, of Cornell University, at Tremont Temple, Dec. 9. Dr. Kimball's topic has not yet been announced.

Business Notes

The Graybar Electric Co. opened Nov. 15, according to an announcement from the New York executive offices of the company, the new Detroit distributing branch at 55 West Canfield Street.

The American Blower Co., of Detroit, Mich., manufacturer of air-handling equipment, announces a new air filter that is claimed to be revolutionary in design, and to eliminate the many difficulties heretofore found in air filters.

The Combustion Service Corp. has been formed with offices at 25 Beaver St., New York City, and will specialize in the design, construction and installation of fuel-burning systems for domestice, industrial, marine and power purposes.

The Research Engineering Corp., 25 Beaver St., New York City, has been formed to afford a medium for the exploitation of industrial undertakings through its plan for the protection, development and administration of industrial inventions.

The Link-Belt Co., it has been just anounced, has established temporary headquarters in New Haven, Conn., at 152 Temple St. R. H. Hagner, formerly of the Philadelphia office, will be Link-Belt's representative at this office, which will be devoted especially to the sale of Link-Belt silent chain and Link-Belt roller chain.

The Botfield Refractories Co., of Philadelphia, Pa., manufacturer of Adamant firebrick, Adamant firebrick cement, and refractory furnace linings, has announced the appointment of the following distributors for Adamant firebrick cement: The Westwater Supply Co., 150 North Third St., Columbus, Ohio; the Klinger-Dills Co., 129-131 North Jefferson St., Dayton, Ohio; the Coan Equipment Co., 236-242 Murray St., Fort Wayne, Ind., and the Cleveland Tool and Supply Co., 1427-1437 West Sixth St., Cleveland, Ohio.

The Chain Belt Co., Milwaukee, Wis., manufacturer of elevating and conveying machinery, has taken over the Stearns Conveyor Co., Cleveland, Ohio, engineers and manufacturers of belt conveyors. This makes the sixth of a group of affiliated companies which now consist of the Chain Belt Co., Sivyer Steel Casting Co., Federal Malleable Co., Interstate Drop Forge, all of Milwaukee, Nugent Steel Castings Co., Chicago, and the Stearns Conveyor Co. of Cleveland. The company will continue to operate as a separate corporation, with Earl D. Stearns as president it was stated.

Trade Catalogs

Temperature Control for Heat Treating Steel—The Bristol Co., manufacturers of Bristol's recording instruments, Waterbury, Conn. Bulletin No. 348 is supplemental to former bulletins on temperature control equipment.

Water Tube Boilers—The E. Keeler Co., Williamsport, Pa. In this catalog are described and illustrated the two types of water-tube boilers manufactured by the company. A page is devoted to the horizontal return tubular type of boiler and the double-duty type, and a section in the rear part of the book is given over to shop methods and equipment. This catalog will be ready for free distribution to any engineer who might be interested in receiving a copy.

Centrifugal Pumps—The Ingersoll-Rand Co. has issued in form No. 7059 the new and revised edition of the Cameron single-stage, double-suction volute pump bulletin dealing with class LV, FV and HV centrifugal pumps. These classes are described and illustrated separately in the order enumerated, a large cross-section of each being given. These pumps are suitable for direct connection to alternating or direct-current motor, steam turbine, gasoline engine, or for belt drive. A section of the bulletin is devoted to specifications and many illustrations of tests and installations.

Fulton Diesels — The Fulton Iron Works Co., Saint Louis, Mo. Claiming advantages for the four-cycle principle, this catalog put out by the Fulton Iron Works Co., is devoted to the four-cycle, air-injection Diesels of 300 to 400 hp. Principles and details touching on lubrication, starting control, design and construction, bedplate, cylinder block and liner, bearings, crankshafts, connecting rod, pistons, valves, Fulton air compressor, fuel-oil pump and governor are considered and depicted in a number of figures.

Coming Conventions

American Association for the Advancement of Science. Annual meeting at Philadelphia, Dec. 27-Jan. 1; Burton Livingston, Secretary, Smithsonian Institution Bldg., Washington, D. C.

American Engineering Council. Annual meeting at Washington, D. C., Jan. 13-15. L. W. Wallace, 24 Jackson Place, Washington, D. C.

American Institute of Electrical Engineers. Winter convention at New York City, Feb. 7-10; F. L. Hutchinson, secretary, 33 West 39th St., New York City.

American Society of Heating and Ventilating Engineers. Annual meeting at St. Louis, Mo., Jan. 25-28; A. V. Hutchinson, secretary, 29 West 39th St., New York City.

American Society of Mechanical Engineers. Annual meeting to be held at Engineering Societies Bldg., 29 West 39th St., New York City, Dec. 6-9. Dr. Calvin W. Rice, secretary.

American Society Refrigerating Engineers. Annual meeting will be held at Hotel Astor, New York City, Dec. 6-8. Wm. H. Ross, secretary.

Chicago Power Show, at Chicago, Feb. 15-19. G. E. Pfisterer, managing director, 53 West Jackson Blvd., Chicago.

Engineering Institute of Canada. Richard John Durley, secretary, 176 Mansfield St., Montreal, Que. The forty-first annual general and general professional meeting will be held at Montreal on Thursday, Jan. 27, and will be adjourned to reconvene at Quebec City at the Chateau Frontenac Hotel Feb. 15, continuing on the two succeeding days.

National Electric Light Association. A. Jackson Marshall, secretary, 29 West 39th St., New York City. Annual convention at Atlantic City, week beginning June 6.

National Exposition of Power and Mechanical Engineering. Fifth Annual Exposition at Grand Central Palace, New York City, Dec. 6-11.

National Marine Engineers' Beneficial Association. Fifty-third annual convention at Washington, D. C., Feb. 14. Albert L. Jones, secretary-treasurer.

Herringbone Speed Reducers — The Foote Bros. Gear & Machine Co., 215 North Curtis St., Chicago, Ill., issues Catalog 100 on the IXL continuous tooth herringbone speed reducers, developed by the company to meet the requirements for heavy duty, high speed and quietness of operation. The gears used in IXL reducers are of the continuous tooth type made with 30 deg. helix angle and 20 deg. pressure angle to insure smoother action and greater bearing surface. They are made in three general types, the single reduction type SH, the double reduction type DH, and the triple reduction type TH. All units are reversible and can be run in either direction, made in capacities up to 150 hp. and reduction ratios up to 250 to 1.

Raymond Pneumatic Feed Control— The Combustion Engineering Corp. This catalog is particularly interesting because, for the first time, it describes in detail the new Raymond pneumatic feed control which has been applied to all Raymond Roller Mills. The entire action of this control is pneumatic and the only movements which take place in the mechanism are the opening and closing of two small valves in the controller, and the collapsing and inflation of the diaphragm of the pawl-lifting mechanism.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run except Pittsburgh gas slack:

Bituminous Net Tons	Market Quoting	Nov. 15 1926
Pool 1	New York	$4.00@$4.25
Smokeless	Boston	5.79
Clearfield	Boston	2.75@ 3.50
Somerset	Boston	3.00@ 3.50
Kanawha	Columbus	3.50@ 4.25
Hocking	Columbus	2.50@ 3.00
Pittsburgh	Pittsburgh	2.50@ 3.00
Pittsburgh gas slack	Pittsburgh	2.00@ 2.40
Franklin, Ill.	Chicago	2.75@ 3.00
Central, Ill.	Chicago	2.50@ 2.75
Ind. 4th Vein	Chicago	2.50@ 2.75
West Ky.	Louisville	1.75@ 2.25
S. E. Ky.	Louisville	3.75@ 4.50
Big Seam	Birmingham	2.00@ 2.25
Anthracite Gross Tons		
Buckwheat No. 1.	New York	2.35@ 3.50
Buckwheat No. 1.	Philadelphia	2.40@ 3.00
Birdseye	New York	1.35@ 2.00

FUEL OIL

New York—Nov. 18, light oil, tank-car lots; 28@34 deg. Baumé, 5¾c. per gal.; 36@40 deg., 6¼c. per gal. f.o.b. Bayonne, N. J.

St. Louis—Nov. 12, tank-car lots, f.o.b. St. Louis; 24@26 deg., $2.05 per bbl.; 26@28 deg., $2.10 per bbl.; 28@30 deg., $2.15 per bbl.; 30@32 deg., $2.20 per bbl.; 32@36 deg., gas oil, 6.1c. per gal.; 38@40 deg., 7.7c. per gal.

Pittsburgh—Nov. 9, f.o.b. local refinery; 30@34 deg., fuel oil, 6½c. per gal.; 36@40 deg., fuel oil, 6¾c. per gal.

Philadelphia—Nov. 11, 27@30 deg., $2.52@$2.58 per bbl.; 13@19 deg., $1.59 @$1.65 per bbl.

Cincinnati — Nov. 15, tank-car lots f.o.b. local refinery, 24@26 deg. Baumé, 6¼c. per gal.; 26@30 deg., 6⅝c. per gal.; 30@32 deg., 7c. per gal.

Chicago—Nov. 6, tank-car lots f.o.b. Oklahoma, freight to Chicago, 92c. per bbl.; 24@26 deg., $1.35 per bbl.; 26@30 deg., $1.45; 30@32 deg., $1.65.

Boston—Nov. 15, tank-car lots f.o.b. 12@14 deg. Baumé, 4.8c. per gal.; 28@32 deg., 6c. per gal.

Dallas—Nov. 9, f.o.b. local refinery, 26@30 deg., $1.70 per bbl.

New Plant Construction

Ark., Blytheville—Drainage District, 17, Mississippi County R. C. Rose, Pres., awarded contract for the construction of a motor driven pumping plant, electrically equipped, to Fairbanks-Morse & Co., Inc., 900 South Wabash Ave., Chicago, Ill. Estimated cost $103,341.

Ark., Hot Springs—Sisters of Mercy Hospital, c/o G. A. Callahan, Chn., will readvertise for bids for the construction of a 5 story hospital including steam heating system, three elevators, etc. Estimated cost $750,000. H. P. Hess, 1237 North Taylor St., St. Louis, Mo., is architect. Former bids rejected.

Ariz., Phoenix — Pacific Hotels Co., awarded contract for the construction of a 12 story hotel at Central and Fillmore Aves. to Trewhitt Shields Co., Edwards Wildey Bldg., Los Angeles, Calif. Estimated cost $1,200,000. Steam heating and cooling systems and 4 electric elevators will be installed.

Calif., Eureka—Dept. of Public Works, J. W. Griffiths, Supt., plans to purchase a centrifugal pump, 300,000 g.p.d., against 70 lb. head, 14 ft. suction lift, also motor.

Calif., Los Angeles—Title Insurance & Trust Co., Title Insurance & Trust Bldg., awarded contract for the construction of a 10 story stores and office building at Spring and 5th Sts. to Scofield Engineering Construction Co., Pacific Finance Bldg. Estimated cost $2,250,000.

Calif., Los Angeles—Warner Bros., Hollywood, awarded contract for the construction of a 6 story theatre and office building at Hollywood Blvd. and Wilcox Ave. to Lange & Bergstrom, 800 Washington Bldg., Los Angeles. Estimated cost $2,000,000. Steam heating system, electric elevators, etc., will be installed.

Calif., Modesto—Modesto Irrigation Dist., plans the construction of a stepdown plant in connection with Hetch-Hetchy power project. R. J. O'Connell is electrical engineer.

Calif., San Luis Obispo—County Supervisors, will receive bids until Dec. 6 for the construction of a waterworks system including well, 100 ft. deep, supply pump house, one 225 to 275 g.p.m. centrifugal pump, 200 ft. head, with electric motor, one booster pump with motor, etc. for Waterworks Dist. 2. C. C. Kennedy, Call Bldg., San Francisco, is engineer.

Colo., Denver—Bureau of Reclamation, will receive bids until Nov. 29 for furnishing and installing two switching towers in Guernsey power plant, North Platte project, Nebraska-Wyoming and the Minidoka power plant, Minidoka project, Idaho.

D. C., Washington—Constructing Quartermaster, Munitions Bldg., will receive bids until Nov. 24 for the construction of a boiler house at Bolling Field.

D. C., Washington—U. S. Engineers Office, will receive bids until Dec. 11 for two motor driven pumping units for water supply project.

Fla., Jacksonville—U. S. Engineers Office, War Dept., Washington, D. C., will receive bids until Dec. 6 for the installation of a dredging pump in U. S. dredge "Welatka" here.

Ill., Chicago—Dept. of Public Works, A. A. Sprague, Comr., City Hall, will receive bids until Nov. 30 for furnishing one 50 kw. steam-driven, 240 v. a.c. generator at Mayfair pumping station, 4850 Wilson Ave., also one 75 kw. steam-driven, 125 v. d.c. generator at Central Park Ave. pumping station, 1015 South Central Park Ave.

Ill., Chicago—A. L. Farwell, 1301 Ritchie Ct., will soon award contract for the construction of a 9 story office and stores building at Michigan Ave. and Erie St. Estimated cost $1,000,000. P. B. Maher, 157 East Erie St., is architect.

Ill., Chicago—One Thousand Three Hundred One North State Building Corp., J. H. Beuttas, Pres., 720 Cass St., awarded contract for the construction of a 15 story hotel at Goethe and North State Sts. to B-W Construction Co., 720 Cass St. Estimated cost $2,000,000.

Ill., Chicago—N. Riback & M. W. Fried, 237 South Market St., are having sketches made for the construction of a 12 story store and office building at 318 West Adams St. Estimated cost $650,000. Loebl & Schlossman, 612 North Michigan Ave., are architects.

Ill., Chicago—Syndicate, c/o A. Kruggel & Co., 4857 Broadway, is having plans prepared for the construction of a 12 or 15 story apartment at Wellington Ave. and Sheridan Rd. Estimated cost $1,500,000. Roy F. France & Co., 155 North Clark St., are architects.

Ill., Chicago—H. Zisook, 1209 East 55th St., is having plans prepared for the construction of an apartment, including refrigeration plant, at Lake Park Ave. and 47th St. Estimated cost $750,000. Thos. R. Bishop & Son., 35 South Dearborn St., are architects.

Ia., Sioux City—Frances Bldg. Co., A. Sanford, Pres., 833 Frances Bldg., will receive bids until Dec. 1 for general contract for the construction of a 4 and 6 story theatre and office building at Sixth and Pierce Sts. Estimated cost $1,500,000. W. & G. L. Rapp, State Lake Bldg., Chicago, Ill., are architects.

Me., Livermore Falls — International Paper Co., 100 East 42nd St., New York, N. Y., awarded contract for the construction of a boiler house here to Domill Construction Co., 100 East 42nd St. New York. Estimated cost $750,000.

Mass., Cambridge (Boston P. O.)—Viscol Co., 200 First St., is in the market for a 1 hp., d.c. 110 v. 50 r.p.m. motor.

Mass., Charlestown (Boston P. O.)—Bean & Co., 16 Frothingham Ave., is in the market for a 6 hp. K. oil engine.

Mass., Worcester—Owner, c/o J. D. Mason, New Park Hotel, plans the construction of a hotel. Estimated cost $1,250,000. Architect not selected.

Mich., Detroit—Dept. of Public Works, will receive bids until Dec. 8 for furnishing and erecting one 250 cu.ft. per sec. at 25 ft. head motor driven centrifugal pump in connection with Connors Creek Sewage & Storm Water pumping station, Jefferson and Clairpointe Aves. P. A. Fellows, City Hall, is engineer.

Mo., Grand Falls (Joplin P. O.)—Empire District Electric Co., 15th and Michigan Sts., Joplin, plans the installation of a central frequency changer and switching sub-station here. Estimated cost $200,000. Private plans.

Mo., St. Louis—St. Anthony's Hospital, Grand and Chippewa Sts., will receive bids about Nov. 30 for the construction of a 5 story hospital at Arkansas and Chippewa Sts. V. J. Klutho, Syndicate Trust Bldg., is architect.

Mont., Hysham—City is having plans prepared for the construction of a waterworks system including pumping plant, etc. Estimated cost $15,000. R. H. Fifield, is engineer.

Neb., Lyman—City, B. Green, Clk, will receive bids until Nov. 30 for waterworks improvements including well, one pump and motor, tank on tower, etc. Swizer & Finley, Scottsbluff, are engineers.

N. J., Jersey City—Bd. of Freeholders of Hudson Co., W. O'Mara, Clk., Court House, is having plans prepared for the construction of a 7 story hospital at Clifton Pl. Estimated cost $1,000,000. C. H. Ziegler, 75 Montgomery St., is architect.

N. Y., Brooklyn—Bush Terminal Inc., Foot of 43rd St., awarded contract for the construction of a power house to Turner Construction Co., 244 Madison Ave., New York. Estimated cost $1,500,000.

N. Y., Middletown—State Hospital Comn., Capitol, Albany, will receive bids until Dec. 8, for the installation of refrigeration plant in Middletown State Hospital, here.

N. Y., New York—G. T. Brokaw, 522 5th Ave., awarded contract for the construction of a 13 story apartment at 5th Ave. and 79th St. to G. B. Beaumont, 475 5th Ave. Estimated cost $1,000,000. Two electric elevators will be installed.

N. Y., New York—M. Ginsberg, c/o E. Roth, 119 West 40th St., Archt., is having plans prepared for the construction of a 25 story hotel at 50th St., and Lexington Ave. Estimated cost $2,500,000.

N. Y., New York—Nine Hundred West End Ave. Corp., c/o J. M. Felson, 250 West 57th St., Archt., will soon receive bids for the construction of a 16 story apartment including 4 electric elevators on West End Ave. Estimated cost $1,500,000.

N. Y., New York—H. H. Uris, 533 West 26th St., is having plans prepared for the construction of a 21 story office building at 60 Broad St. Estimated cost $2,500,000. Buchman & Kahn, 49 West 45th St., are architects and engineers.

N. Y., Syracuse—Central Offices Inc., awarded contract for the construction of a 22 story office and stores building at Genesee and Warren Sts. to J. H. Taylor Construction Co., 31 Union St., New York. Estimated cost $1,000,000. Steam heating system will be installed.

O., Cleveland — Appalachian Hardwood Lumber Co., 5100 Brookpark Rd., awarded contract for the construction of a mill and boiler house to H. E. Klefman Co., 2844 Lorain Ave.

O., Cleveland—Syndicate, c/o S. Kaplan, 1402 Prospect Ave., is having preliminary plans prepared for the construction of a 14 story hotel at East 14th St. and Prospect Ave. Estimated cost $1,500,000. F. W. Bail, Hanna Bldg., is architect.

Okla., Antlers—City voted $23,000 bonds for waterworks improvements including new filtration plant, motor driven pumps, motors, etc. Gantt-Baker Co., 1116 West Main St., Oklahoma City, is engineer.

Okla., Bokchito—City is having preliminary plans prepared for the construction of a waterworks system including well, triplex pump and motor, etc. Estimated cost $20,000. Gantt-Baker C , 1116 West Main St., Oklahoma City, is engineer.

Okla., Paden—City plans an election Dec. 2 to vote $36,000 bonds for the construction of a waterworks system including wells, deep well pumps and motors, etc. V. V. Long & Co., Colcord Bldg., Oklahoma City, are engineers.

Pa., Ardmore—E. A. Fills, 40 Linwood Ave., awarded contract for the construction of a 3 story apartment at Linwood and Argyle Sts. to H. H. Conway, 5800 Walnut St., Philadelphia. Estimated cost $1,000,000. Vacuum heating and refrigeration systems will be installed.

Pa., Philadelphia—Fox Film Corp., 16th and Market Sts., plans the construction of a 15 story theatre and office building at 17th and Market Sts. Estimated cost $5,000,000. C. H. Crane, 542 Griswold St., Detroit, Mich., is architect.

Tex., San Antonio—San Antonio Public Service Co., St. Marys St., has acquired a site and plans the construction of a substation power plant at McCullough Ave. and International Great Northern R.R. tracks. Private plans.

Wis., Milwaukee—Holabird & Roche, 104 South Michigan Blvd., Chicago, Ill. Archts., will receive bids until Dec. 6 for the construction of a 23 stry hotel on Grand Ave. here for Schroeder Hotel Co., 86 Michigan St. Estimated cost $4,000,000.

Wis., Random Lake—Sommer & Sons, is having preliminary plans prepared for the construction of a condensory. Estimated cost $50,000. E. A. Stubenrauch, 629 North 8th St., Sheboygan, is architect. Special machinery and motors will be required.

Ont., Toronto—City plans the construction of a low lift electrically operated pumping plant, 30,000,000 gal. capacity. Estimated cost $40,000. R. C. Harris, City Hall, is engineer.

Ont., Toronto—J. T. Ransom, Metropolitan Bldg., plans the construction of a 4 story apartment including steam heating and refrigeration systems at Yonge St. and Farnham Ave. Estimated cost $500,000. Private plans.

Ont., St. Thomas—Pere Marquette Ry. Co., Fort St. Union Depot, Detroit, Mich., plans the construction of a woodworking plant here. Estimated cost $125,000. H. A. Cassil, is chief engineer. Electric motors will be required.

Que., Shawenegan Falls — A. Giguere, plans a 200 hp. water power development on Little River, here. Estimated cost $800,000.